International Cooperation in Space

by
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PREFACE

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Cooperation is easily established as an objective but is far more difficult to implement If it is to achieve meaning in the affairs of men it must progress beyond lip service slogans and token exchanges It must go forward substantively and realistically within the existing rather than always a future political framework, and with due regard for modes and channels for first and intermediate steps and for ultimate objectives

An elementary but sometimes neglected prerequisite for construc tive contributions to cooperation in space whether at editorial polit ical or technical levels is some knowledge and understanding of the history and present status of the subject—its failures and successes the institutions involved and the technical and political constraints which apply

This small book is hopefully an early primer on the subject The very real achievement it suggests is the product of the work and devotion of many people in this country primarily in the National Aeronautics and Space Administration the National Academy of Sciences and the Department of State

Chief among the first group have been Dr Hugh L Dryden whose distinguished personal role will be evident in what follows Dr Homer E Newell Dr John W Townsend Mr Robert Krieger Dr Robert

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Fellows and many others at NASA headquarters at the Goddard Space Flight Center, at the Wallops Island Station and elsewhere

In the Department of State wise and ready support of cooperative space objectives has been the consistent contribution of Mr Philip Farley Mr Robert F Packard and Mr Peter Thacher Mr Leonard Meeker has provided sound and sensible leadership in the definition and consideration of legal aspects of international space activity

Dr Richard W Porter and Dr Hugh Odishaw, of the National Academy of Sciences Space Science Board have made fundamental and continuing contributions to the personal and institutional foundations for cooperation in space matters

The observations made and conclusions reached in the pages to follow are entirely the personal responsibility of the author and do not carry any official endorsement or approval

CONTENTS

EPIGRAPH

This world of our understanding of nature and the power that it gives us varies not only with time but also among individuals and institutions What one can do is beyond the grasp of another Yet whatever ephemeral and elusive qualities this world of science and technology may appear to have it is exceedingly powerful though extremely obdurate The possibilities of great things are within our grasp and men and institutions exist by means of which these great things can be accomplished

J R Pierce Satellite Science and Technology *Science* (July 19 1963) p 244

BACKGROUND

AMBIVALENCE

Two months before his death President John F Kennedy stood be fore a microphone in the General Assembly of the United Nations in New York and proposed that the Soviet Union and the United States together explore new possibilities for cooperation in the investigation of outer space even to the point of joining forces in the major task of sending men to the moon and back The President said

> Finally in a field where the United States and the Soviet Union have a special capacity—the field of space—there is room for new cooperation for further joint efforts in the regulation and exploration of space I include among these possibilities a joint expedition to the moon Space offers no problem of sovereignty by resolution of this Assembly the members of the United Nations have foresworn any claims to territorial rights in outer space or on celestial bodies and declared that international law and the U N charter will apply Why should the United States and the Soviet Union in preparing for such expeditions become involved in immense duplications of research construction and expenditure? Surely we should explore whether the scientists and astronauts of our two countries—indeed of all the world—cannot work together in the conquest of space sending some day in this decade to the moon not the representatives of a single nation but the representatives of all humanity [1]

The President s speech met with a thoroughly mixed reaction a reaction which should be highly instructive to those interested in the ways and means of cooperation The United Nations as the prime forum of international cooperation gave the President's words a warm reception as might be expected The press reported that the proposal to explore cooperation in a lunar expedition stirred [illegible]

thusiastic reaction among the representatives of UN member states[2] On the domestic scene, too there was considerable approbation A number of newspaper editorials praised the President s overture in one case calling it an eminently sensible suggestion [3] in another saying whether or not there is ever any joint journey to the moon or elsewhere in space there is every reason why we should try now to find something that gives us more security than today's constant risk of eternal destruction [4] *The New York Herald Tribune* expressed the opinion that if agreement could be reached on cooperation in this field it would represent not only an important savings but a possible move toward international control of missiles [5] (The writer reflected the opinion that cooperation in the peaceful use of rocket power might in some way lead to the development of constraints upon its military uses)

But a contrary view was if anything even more in evidence *The New York Times* said that the proposal represented a shift in the strong emphasis President Kennedy has been placing since 1961 on the race to the moon and on the importance that the United States not be second in that race [6] Other newspapers also thought they saw such a contradiction in objectives *The Wall Street Journal* suggested that the President s emphasis on cooperation not competition in the effort to land men on the moon is likely to undercut one of the major selling points used by other Administration leaders particularly in the National Aeronautics and Space Administration to justify the priority placed on the United States own space program '[7]

A similar division of sentiment became quickly apparent in the Congress Representative Pelly (Rep Wash) introduced an amendment to the federal space agency s appropriation bill still before the Congress at the time to prohibit the expenditure of any of its funds in the joint manned lunar program with the Soviet Union (The amendment was later modified to require only prior approval by the Congress of such an expenditure) On the other hand Senator Fulbright (Dem Ark) drafted a joint resolution aimed at encouraging the President to go as far as possible in his efforts to develop cooperation with the Soviet Union in space activities Pelly s amendment was

enacted into law but Fulbright s draft resolution was never pressed

A number of Congres men thought the President had raised a basic issue between cooperation and competition, they professed privately or to the press to be confused over the basic purposes of the national space program Some observers concluded that the President s es pousal of cooperation could only mean that he sought relief from a difficult costly and allegedly increasingly unpopular national com mitment[8] Within a few days it was being widely suggested that the President s propo al would have an adverse effect on the space agency s pending budget submission for any of several reasons congressional pique at not having been consulted in advance basic opposition in some quarters to the space program itself and con fusion of the national purpose as between preeminence or coopera tion in the moon race

That the President s United Nations proposal created surprise and confusion is clear enough Yet the proposal was entirely consistent with the specific provisions for international cooperation contained in the National Aeronautics and Space Act consistent with numerous earlier public expressions by the President of his strong personal in terest in space cooperation and consistent too with the successful conclusion only a month earlier of a bilateral space agreement with the Soviet Union That agreement had developed directly from well publicized correspondence between the President and Mr Khrushchev during the previous year But apart from the e specific precedents he essential duality of cooperation and competition in space activity should have been plain enough from the start Both factors had had long backgrounds

The President s UN proposal was only another in a long series of efforts to promote international cooperation in space—as an alterna tive to the spread of the cold war into a new dimension as a device for achieving rapport among nations (especially the United States and the Soviet Union) and as a measure to minimize the world tensions which a covert program might provoke

Indeed the space age had itself come into being in a context of cooperation across national boundaries The first effective proposals

In fact these ingredients were sufficient to assure a basic ambivalence in the character of the space age from its inception Sputnik I s shiny new prestige reflected not only its international scientific heritage but a strong national power rivalry as well Long before the first launching an atmosphere of competition for primacy developed fed by the press but also by occasional spokesmen for the US program The circumstances of the first launchings—the Soviet success and the American failures the disparity in the weights of satellites placed in orbit by the two countries—contributed further to the competitive cast of things The impact of the Soviet Union s unexpected first and the dim portents of that primacy for technological leadership in the world combined to make Sputnik I a sharp spur to competition The Soviet Union was quick to trace its victory to the virtues of its social system Americans on the other hand were equally vociferous in urging strenuous efforts to catch up in order to expunge any reflection upon their own system Thus the battle was joined

The Soviet Union proceeded from one spectacular space feat to another photographing the far side of the moon placing the heaviest weights and the first man in orbit then the first woman and broadly hinting the achievement of a significant maneuvering capability in space associated with the near rendezvous of two satellites In the United States space budgets beginning at some 300 millions of dollars in 1959 very nearly doubled each year until they reached an approximate levelling off figure of something in excess of five billions of dollars in 1963 Strong efforts were concentrated upon the development of large boosters and the achievement and advancement of manned flight in order to catch up to the Soviet Union The goal of manned lunar landing and return before the end of the decade was set as the next major test of the relative abilities of the two nations

Unquestionably then a clear duality dogs both the history and the prospects of international partnership in the conquest of man s newest intellectual and technological frontier On the one hand there has been the strong appeal of world cooperation made even more attractive by the ease with which scientists seem able to collaborate in

their own fields by the absence to date of vested interests in space and by an intellectual challenge so vast that it seems to demand a response from all men rather than from one or two of his nations On the other hand there has been the categorical imperative of technological leadership with all that this might mean to each nation in economic political and military security

There is nothing unique in this ambivalence in space It has applied for example to the nuclear field as well In the atoms for peace program of the 1950s the tender shoots of science and peace were to be grafted belatedly upon a main trunk deeply rooted in weapons systems The nations were to be drawn back from the nuclear weapons abyss and given an opportunity to cooperate in exploiting the peaceful benefits of atomic secrets In the case of space however the terrors were only vague and future the possibilities for peace and cooperation seemingly more immediate For the space age did not dawn in the shadow of a mushroom cloud, and there were no real space weapons in view, only insubstantial portents

In the broadest sense the duality of motivation experienced in space only reflects the fundamental choices before us at every critical juncture in the postwar world However contradictory or mutually exclusive they may seem these choices are nevertheless pursued simultaneously Thus we hope that diplomacy and time may moderate the political systems which are hostile to us At the same time we seek to maximize pressure upon those systems through encircling political alliances and international economic pressures We work to bring the world together in the United Nations and at the same time to buttress one half of it against the rest We hope that a powerful domestic military posture will protect us from holocaust But we try to avoid holocaust also by seeking increased understanding in the exchange of scholars farmers and musicians

Inevitably this fundamental ambivalence was mirrored in the principal response of the United States to the challenge of space That response coming only a few months after the launching of Sputnik I by the Soviet Union was the creation by the Congress of a new federal agency to carry on the nation's space activity

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establishing this agency, the Congress gave full expression to the dichotomy between cooperation and competition The National Aeronautics and Space Act was expressly designed to bring world leadership in space technology and exploration to the United States. But it is an arresting fact that the Congress, while plunging the nation into competition for preeminence simultaneously provided that

> *the space activities of the United States shall be conducted so as* to contribute materially to cooperation by the United States with other nations and groups of nations in work done pursuant to this Act and the peaceful application of the results thereof[13]

Thus the new agency the National Aeronautics and Space Administration was directed to employ the tools and techniques of space research common in good part to science and the military, to advance the national security on the one hand and on the other to establish cooperative ties with other countries While facing up to the grim reality of competition between the great powers the Congress nevertheless elected to place some hope if not faith in the simultaneous practice of cooperation—

> For use almost can change the stamp of nature and master ev n the devil or throw him out with wondrous potency[14]

It was with this mandate and this background that both courses of action—the competitive and the cooperative—were pursued simultaneously in the early years of the space age (The parallel prosecution of both was of course entirely conscious NASA s Administrator James E Webb said on more than one occasion that space like Janus looks in two directions[15] This was only part and parcel of the age old strategy of pursuing the battle vigorously while seeking and preparing for an armistice President Johnson put it most simply in his first message to the Congress when he said that *the United States intends to carry out a manned lunar landing with the Soviet Union if possible alone if necessary* *And he repeated the* principle more broadly soon thereafter saying The United States hall welcome any who wi h to join with us in seeking to serve the common good of mankind But if others are not willing—or if they

fessional subject matter And if they are generally effective does this apply to a particular field of interest such as space? In fact what experience has there been with efforts to promote cooperation in space matters and what is the nature of that experience? How does the Soviet Union figure in it? In view of the widespread popular criticism and unquestioned shortcomings of some international efforts what can we learn of the do s and don ts of cooperative enterprise of the channels or mechanisms which work best for particular objec tives, of the objectives to be ought and the limitations which attach or should be attached to them? Above all what practical benefits can realistically be expected from joint efforts among the nations in this field?

Otherwise like the premature reports of Mark Twain s death the life and prospects of international cooperation in space research and exploration may be greatly exaggerated

THE INTERNATIONALITY OF SCIENCE

The importance given science as a medium for cooperation among peoples is one of the unique features of our times But is science a more binding force a more plausible counter to xenophobia and nationalism than say commerce or religion? Why have governments, and the government of the United States in particular selected science as a potion for the easing of political tension?

The preeminence of science as an international mortar is very widely subscribed to and especially by scientists A recent letter to *Science* asked

> What groups tribes or subcultures have the following traits that they are a definite in group that their special tradition goes back for generations and that they are truly international main taining their language their rituals and their own purposes in dif ferent countries? There are the Bohemians from the Left Bank to the beatniks there are the Jesuits the gypsies, the ballet dancers the Jews and the professional naval officers. But there are very few international groups even unorganized ones, as old as the international community of science In the organized

> line there are the Communists the Catholics and the UN civil service Who else? That is jus about all the organized commu nities that we have In the world we can document science is now one of the oldest distinct traditions still represented in a living community [18]

This viewpoint has been stated in a more directed way by a former Science Advisor to the President who said,

> The significance of international scientific activities to the re lations between nations is perhaps the most important of the roles science and scientists can play in the sense that international activities of science are part of the life blood of science but new in its potential impact on political relations
>
> For science is today one of the few common languages of man kind it can provide a basis for understanding and communication of ideas between people that is independent of political boundaries and of ideologies Science also provides a sometimes unique op-portunity for cooperative endeavors that can contribute in a major way to the reduction of tensions between nations [19]

Others have sought to suggest explanations for these ties and their influence

> Because of the similarity in outlook of scientists all over the world their increased influence on the national policies of different coun tries should increase the ease of international communication Their greater than average capacity for abstraction and gener alization will favor policies based on long range rational planning —policies in which the enlightened self interest of individual na tions or political systems is bound to become coordinated with the common well being of mankind [20]

There is a sense in which these views may be readily accepted in that there are characteristics of science which ease its way as a builder of contacts among scientists of all nations The pursuit of science requires the exchange of observations which in turn requires the ex change of techniques and of results Since the emphasis is upon facts, the elements of conflict are reduced to a minimum Competition does exist in science, sometimes in exaggerated degree, but generally it does not begin to approach the survival tests of commercial rivalry or the bloodletting of religious contest

Careful examination of this argument however begins to uncover

an excessive reliance upon logic divorced from life and especially from history Even a casual reading of international commercial history reveals in international finance in cartels and trusts a community whose ties (as in the wars between Germany and the United States) may have demonstrated far greater solidarity under more trying conditions and exerted greater weight in the affairs of men than anything jointly carried forward through the international ties of science

The notion that the scientist can play a special and peculiarly effective role in establishing and cementing improved relation hips among nations rests on old and honorable conviction We are fond of pointing out that Benjamin Franklin directed the fledgling US Navy to avoid interference with Captain Cook s scientific voyages under the British flag in the South Seas although the war between the colonies and their erstwhile British sovereign was then in progress This line of argument is carried to apotheosis in Gavin de Beer s book *The Sciences W ere Never At W ar* Here it is recorded that the famous English scientist Jenner at the height of the Napoleonic wars between England and France used his influence to arrange exchanges between scientists interned by the two sides we are told again of Humphrey Davy s celebrated trip to Paris during the same hostilities to receive an award and demonstrate various experiments in his hotel room there is the story of a British sea captain who lent assistance to a French scientific expedition encountered in Australian waters in the same period

Two points are of interest in these accounts First many of the incidents themselves do not bear examination in depth Even as Franklin wrote out his safe conduct for the great English navigator Cook had already been killed in the Hawaiian islands so the gesture was never put to the test De Beer s chivalrous Briti h captain him self later ran afoul of a less thoughtful French authority on his way home from Australia and spent the next seven years as a prisoner of war This painful footnote is explained away as an unaccountable lapse in international consideration for science even though it represented retaliation for seizure (by other Briti h forces) of a French

ship bearing scientific specimens of that same expedition so well treated earlier by our British captain[21] The incident in full—and others like it—tell us little more than that there were gentlemen and nongentlemen in war Consideration and generosity have never been the special province of scientists and prisoner exchanges have been common among all sorts of people

Second, the incidents suggesting that scientific ties withstand the onslaught of divisive war are isolated examples given without reference to overwhelming evidence to the contrary The viewpoint of Napoleon himself who always penetrated quickly to the core of sentimental matters is interesting Napoleon was delighted with Monge the leader of his scientific establishment in the invasion of Egypt because he represented the epitome of what Napoleon expected from a scientist to serve the fatherland seemed to him the ultimate aim of science"[22] This point is further illustrated in our own history The development of organized science in the United States shows a voluntary responsiveness to the national interest which would have satisfied even Napoleon

Most major steps in the organization of science in the United States have coincided with war—the Civil War and both World Wars When the National Academy of Sciences was brought into being by charter of the Congress in March 1863 so far from ignoring the Civil War then in progress or extending a disinterested professional hand to Southern colleagues the new Academy within a month imposed loyalty oath to the Union upon its members"[23] When the first World War loomed on the horizon and George Ellery Hale set about revitalizing the National Academy and establishing the broader National Research Council (both nongovernmental institutions), his specific objective was to help the United States in the event of a war with Mexico or Germany It is not without significance that Hale was Foreign Secretary of the Academy, responsible for relations with the international scientific community He was strategically placed to take Humphrey Davy s view that if the two countries are at war the men of science are not That would indeed be a civil war of the worst description we should rather, through the instrumental

ity of the men of science soften the asperities of national hostility"[24] But he did not. In the Academy he moved and secured unanimous passage of a resolution "to offer the resources of the Academy to the President of the United States in the event of a break in diplomatic relations with *any* other country" (italics supplied).[25] In August 1916 Hale went abroad to establish liaison with the allies for scientific purposes. Much of the Academy went into uniform, even its President!

With World War II the refugee scientists, fearing that Hitler might acquire a decisive weapon, "could no longer rely on the solidarity of the scientific community to forestall such a calamity."[26] They recognized that German scientific circles, as those in other countries, would act from patriotic motives to give any useful product to their government, *and so the refugees took their secrets to the side they* favored, the West. Nor were the refugee scientists the only ones to make such a firm political commitment. In 1939 Professor Percy Bridgman decided to close the doors of his Harvard laboratory to students from nations under dictatorial rule. American scientists began to impose a voluntary censorship on their publications concerning atomic energy.[27]

In the period since the wars we find that among friendly nations there is sensitivity with regard to the emigration of scientists from the homeland to another country and that national policy to constrain such emigration is debated.[28] Among cold war antagonists the general alignment of scientists on technical grounds with the political positions of their governments in disarmament negotiations has been an obvious fact. In other areas, too, the responsiveness of Soviet scientists to political imperatives simply provokes a defensive reaction in their western counterparts, driving the latter to a far greater consciousness of nonscientific considerations in matters involving scientific organization and exchange than would be normal for them.

The evidence appears to be overwhelming that scientists confronted with the exigencies of national need have reacted much as other patriotic citizens, professional and nonprofessional. In part this follows from an interaction between science and government which

produces a rough alignment even in democratic countries International ties real or fancied have not weighed in the balance in any significant way The maintenance of contact, the continued publication of literature, personal intercessions—these occur in many fields and among many individuals When we say that science is international, we must then mean that it is international where scientific matters of essentially professional character are concerned and not really where political matters are concerned Were it otherwise, the profession would include a legion of traitors notorious in history, whereas the treasonable scientists can in fact be counted on the fingers of one hand

The notion that a particular group possesses some uniquely common bond throughout the world is in itself rather common Charles Burton Marshall has commented on this phenomenon in amusing fashion He notes that at various times it has been suggested that global understanding could be uniquely served by organizations of mothers (because everybody has them) nudists (who alone see us as we really are) international bureaucrats (because they are disinterested) artists (because they have an unique calling to the love of humanity), and lawyers theologians and scientists for similar special reasons [29]

Our consideration of the realities of international cooperation in space, as in any other scientific field will profit if we discard sentiment and tenuous history It is doubtful that an international mystique lends science *special* value as a vehicle for cooperation for science is demonstrably subject to normal human limitations and nationalist constraints, science is of critical value for cooperation because of the critical dangers with which it is associated Just as these dangers have appeared greatest in the case of the atom and space so have the principal efforts to establish international cooperation materialized in these fields This is true too of the present impulse toward *cooperation in meteorology, a togetherness impelled by the first* dim fears that separately we may come upon the ability to modify the weather

This is not to deny for a moment that the subject matter of science

No scientific program had ever engaged so many people in so many places nor had any so captured the public interest and imagination

Neither the press nor its readers could be expected to take as detailed an interest in the auspices and organization of this vast enterprise as in its oceanographic voyages its satellite launchings and its Antarctic traverses Certainly, they were not prime objects of attention in the very considerable publicity given to the IGY As a consequence the nature of the IGY itself as well as the nature of its succe s have been widely misunderstood The long looked for genie had come out of his bottle and had indeed wrought miracles but he performed his magic in quite a different fashion and with different results from those to which the bemused public testified

A popular impression was that the IGY represented a unified and integrated program of cooperation among governments Newspapers hailing the IGY s success referred to ' special cooperative agreements among many countries and asserted that the thousands of scientists and technicians who had participated including large numbers of Russians and Americans have worked together as if there were no cold war or ideological wall dividing them [37] Unfortunately this impression missed the facts in each and every respect

The IGY involved governments almost exclusively on a purely domestic basis only Its international relationships were conducted by committees of scientists representing not their governments but rather their own scientific institutions [38] These committees took care of the planning and loose coordination of scientific objectives They achieved decisions only where unanimity was possible and they had no authority as committees to implement their programs Instead the scientists took the agreements they had reached back to their national scientific institutions at home which then sought government or other support for their work An astonishing degree of such support was forthcoming but it was essentially self contained there was no significant *integration* of national programs involving governmental agreement For example those nations which participated in the Antarctic programs of the IGY did so at their own bases The US and USSR Antarctic stations were separated by the continent it

self a single scientist was sent by each nation to the other s principal base for each of two years but this was a very rare exception to the rule To the extent that working together' suggests shoulder to shoulder cooperation this was a substantially misleading picture In short the IGY consisted of a collection of national programs independently working toward purely sc entific objectives loosely coordinated bv a nongovernmental mechanism

It is true that the IGY was relatively free of politics But this was largely because political considerations were not often encoun ered in the definition of scientific goals and procedures It is quite true to say that the IGY constructed scientific bridges across political chasms [39] But the bridges had no effect on the chasms these remained and no traffic other than scientific crossed them For example, a dispute arose between the two Chinas over participation in the IGY Mainland China had been a full participant in the preparatory years but repeatedly stated that its participation depended upon nonadmittance of Taiwan China Taiwan, after showing little interest for four years pressed for formal adherence during the last two months before the Year was to begin and produced a small scientific program to justify the action The dispute could not be resolved or scientific grounds and Communist China withdrew [40]

Other political overtones existed but generally did not obstruct the course of the program For instance the Soviet Union organized a series of IGY meetings exclusively among the Iron Curtain countries But in one respect, underlying political difficulties and military considerations in the cold war patently restricted the scope of the IGY The broad success which characterized the scientific effort in virtually all other fields did not extend to the IGY program in space research The Soviet Union s scientific representatives stubbornly restricted IGY agreements for exchange of information in this area As a result unanimous consent to broader agreements could not be obtained And Soviet compliance with even the modest IGY requirements in space science was in good part pro forma Attempts to improve the situation though made through the international scientific machinery of the IGY were unavailing

In the other disciplines which were the subject of cooperative programs during the IGY—such as geomagnetism seismology ionospheric physics and so forth—the cooperating nations, including both the US and the USSR were reasonably forthcoming in contributing raw or reduced data for storage in three great World Data Centers established for the purpose Thus most scientific results were available to scholars in such form as would permit independent research evaluation and criticism But in space research only the United States provided advance details of experiments, extensive information of satellite instrumentation and design telemetry patterns current orbital elements of satellites to permit precise tracking for scientific purposes and results accompanied by critical data point The Soviet Union provided virtually no advance information of a substantive character regarding either its satellite or sounding rocket programs restricted agreements prescribing types of information to be exchanged and released only limited quantities of digested scientific findings such as normally appear in conventional publications [41] While scientist to scientist inquiries for additional information necessary to understand in depth the Soviet scientific work went unanswered efforts were made by Soviet scientists to obtain information of a similar kind from individual US scientists

A notable example was the case of the telemetry tapes (tape recordings of coded scientific data radioed from satellites) During 1958 the Academy of Sciences of the USSR asked for tape recordings of signals received from the first Soviet Sputniks Between 30 and 40 reels of tape were collected in the United Sates and forwarded to the Soviet Union along with a request that the Soviet Union reciprocate by sending to the US similar recordings which American scientists expected had been made of the first American satellites Explorers I and III in the Soviet Union The Soviet response was that the inclination of the orbits of these satellites was so low that they did not carry over the Soviet Union The inclination of Explorer IV was considerably higher providing Soviet technicians with an obvious opportunity to record its signals However no acknowledgment was made to repeated requests for recordings that might have been made At the

without regard to territorial claims and without benefit of treaty their national stations were from the outset established in territory claimed by other countries Moreover the treaty provided only for deferring, rather than permanently settling the political problems of the continent Would the treaty weigh in the balance against the revival of nationalistic claims if economic or strategic interests were to emerge in Antarctica?[44]

Nevertheless it remains most important to recognize that those who molded the IGY were probably far freer from disabling political considerations than would have been the case if governmental representatives had attempted to frame a similar program The scientists were not normally obliged to negotiate with reference to governmental positions extraneous relationships and commitments which must properly concern the political representative

It seems fair to say that the work of the IGY proceeded remarkably well in its proper business science that the participants were forced to yield to political realities on those relatively rare occasions when these were encountered and that no single significant political issue was solved It is closer to the truth to say that science benefited from the near absence of politics than it is to say that science contributed to the resolution of political issues during the IGY Indeed where there was an interplay between science and politics the political realities tended to constrain scientific objectives in some degree

In these few comments upon the most significant international program of cooperation in science the International Geophysical Year enough has been said to suggest that international science is as complex as any other tool for peace that it is not necessarily successful and that its successes may be more limited in character than has been assumed Indeed if international programs for scientific purposes are to succeed even in their own terms, the conditions must be correct *in depth* The IGY was not a mere inspiration nor were its programs created out of whole cloth It was in good part an intensification of effort already existing in each of its scientific disciplines Perhaps most important there had been a previous history of cooperation and exchange among geophysicists stretching back 150 years and

including the experience of two earlier and closely related International Years.[45] Over five years had been spent in planning for the IGY, its objectives were extremely concrete and detailed and a suitable and highly developed organizational complex to plan and implement the program already existed and knew its business well [46] Finally and of great import, many of the scientific objectives of the IGY program—such as oceanographic surveys ionospheric experiments, and space research—were of significant practical interest to the governments which were asked to foot the bills thus lending more solid interest to the enterprise than is commonly appreciated

None of this gainsays the fact that the IGY played a remarkable role in achieving its scientific goals and in contributing to general understanding in an intangible but nonetheless real manner This is not unlike the contributions made toward international understanding through other links between peoples—commercial religious and cultural—but the great scope and support given to the IGY clearly lifted it to an unusual level giving special inspiration and stimulation to the belief that people *could* work together Its indirect and long term effects are certain to be of increasing significance Without question, it brought new public and governmental support to science not only in the Soviet Union and the United States, but in developing countries like India as well [47] the consequences of this latter fact for intellectual and political purposes in the long run may be undoubted It would not be far off to say that the IGY was a notable element among the forces which gave the US national space program its peculiar shape when legislation for that program was considered in 1958.

NOTES

1 September 20 1963
2 *The Evening Star* Washington, D C. (Sept. 21 1963)
3 *The Washington Post* (Sept. 21 1963)
4 *The Hartford Courant* (Sept 22, 1963)
5 *The New York Herald Tribune* (Sept. 21 1963)
6 "News of the Week in Review" (Sept. 22, 1963)

[7] *The Wall Street Journal* (Sept 23 1963)

[8] *The New York Times* (Sept 21 1963) *The Washington Post* (Sept. 24 1963)

[9] The World Committee for the International Geophysical Year (CSAGI) met in Rome in 1954 establishing a Rocket Group for the first time Among its recommendations were the following

> (2a) It is urged that as many countries as possible undertake programs of small rocket soundings and in addition that currently planned small rocket programs be expanded but with no diminution of effort in the large rocket programs
>
> *(2c) CSAGI recommends that the geographic coverage of the large-rocket sounding programs,* now planned by the United States and France be extend d at least during the IGY by the participation of other nations
>
> (?g) In view of the great importance of observations during extended periods of time of extra terrestrial radiations and geophysical phenomena in the upper atmosphere and in view of the advanced state of present rocket techniques CSAGI recommends that thought be given to the launching of small satellite vehicles to their scientific instrumentation and to the new problems associated with satellite experiments such as *power supply telemetering and orientation of the vehicle*

[10] The American announcement made by the President s Press Secretary on July 29 19 5 was as follows

[13] National Aeronautics and Space Act July 29 1958 (Public Law 85 568 85th Congress H R 12575 [72 Stat 426] Section 201)

[14] *Hamlet* Act III Scene IV lines 168 ff

[1] James E Webb address before the Institute of Foreign Affairs (Jan 24 1963)

[16] President Johnson remarks at dedication ceremonies of the National Geographic Society *The Washington Post* (January 19 1964) p A6

[17] Hailsham *Science and Politics* p 28

[18] Michael Amrine Scientists and Jesuits Gypsies and Jews a letter *Science* (November 15 1963) p 913

[19] George B Kistiakowsky *Bulletin of the Atomic Scientists* (April 1960 p 115)

[0] Eugene Rabinowitch from an essay in 1956 quoted by Daniel Bell in *The Washington Post* Book Week (January 5 1964) p 4

[21] Gavin de Beer *The Sciences Were Never at War* (Thomas Nelson & Sons London 1960) pp 112 121 Capt Matthew Flinders in the *Investigator* surveying the coast of Australia in 1801 encountered a French expedition under Nicolas Baudin in the ships *Le Geographe* and *Le Naturaliste* First preparing for action but then exchanging experiences and scientific findings he assisted the French to reunite their separated hips and provided aid for their badly afflicted crews

> The distress of the French navigators had indeed been great but every means were used by the governor [at Port Jackson] and the principal inhabitants of the colony to make them forget both their suff ring and the war which existed between the two nations

De Beer terms it "one of the har h ironies of history and a black page in the records of Anglo-French cultural relations that Flinders was interned for seven years when he stopped at Isle de France on his way home ignorant that war had again broken out But it is equally ironic that this grievous lapse by the French was de Beer says occasioned by an unaccountable British error in eizing one of Baudin s ships *Le Naturaliste* on *its* way home with the specimens gathered during the voyage and in violation of a safe conduct

" J Christopher Herold *Bonaparte in Egypt* p 168

[23] Thi and the subsequent related material are based upon A H Dupree *Science in the Federal Government* (Belknap Press Harvard Univer ity 1957) Regarding the Academy s civil war loyalty oath Dupree says

> The lone reporter of this incident, the geologi t J P Le ley indicated that the discussion got even deeper into the realm of the relation of the Academy and through it science to the government "Someone I willingly forget who argued that we would lose government patronage unless we b d for it with the oath I suspect it was only an unfortunate way of stating a hi her truth that we are children of the government

and the academy is the creation of the government and owes it an oath of allegiance as its first duty (p 143)

[24] de Beer p 204

[25] Dupree p 309

[26] Dupre and Lakoff *Science and the Nation Policy and Politics* Prentice Hall 1962 p 92

[27] Dupre and Lakoff p 92

[28] During 1963 the emigration of senior British scientists especially to the United States became a matter of national concern (See Emigration of Scientists from the United Kingdom Report of a Committee appointed by the Council of The Royal Society 1936) During February 1953 prospective emigrations became so numerous that press accounts suggested the subject might be discus ed by the Prime Minister during his vi it of that month to President Johnson

[29] Charles Burton Marshall Render Unto Caesar *Johns Hopkins Magazine* (May–June 1962)

[30] Warren Weaver A Great Age for Science in *Goals for Americans* (1960)

[31] Thornstein Veblen, *The Place of Science in Modern Civilization* (1906)

[32] The material relating to US support of the International Research Council after World War I is drawn from A H Dupree *op cit* p 330

[33] An account which stresses what is here cited as token recognition across national lines is contained in the *Herald (Vestnik)* of the Academy of Sciences of the USSR October 1963 pp 86–90 This is a survey of the long tradition of scientific relations between Americans and Russians dating back to the middle of the 18th century listing Americans elected to the then St Petersburg Academy of Sciences reporting certain scientific collaborations attempts by the young Soviet to establish contact" with American scientists reciprocal visits and finally the current exchanges organized by governments on a cultural level As is discussed in greater detail in subsequent chapters the *forms* of exchange and cooperation must be distinguished from the *substance*

[34] Hugh Odishaw in an address before the National Press Club Washington D C. (December 4 1958)

[35] Odi haw "International Geophysical Year—A Report on the United States Program *Science* (Jan. 17 1958)

[36] *Ibid*

[37] e.g., an editorial in *The Washington Star* (Jan. 10 1959)

[38] See Ronald Fraser *Once Round the Sun* pp 97–102 for a graphic description of the organization of the IGY

[39] Walter Sullivan *Assault on the Unknown* p 417

[40] For an authoritative account of the IGY dispute between the two Chinas see Sullivan *op cit.*, p 36 ff

[41] Sullivan *op cit.*, pp 403–407 See also Homer E. Newell "IGY

Conference in Moscow Report on the Organizational Setup and on the Soviet Presentation of their Rocket and Satellite Work *Science* (Jan 9 1959) p 79 and Lloyd V Berkner Ed Manual on Rockets & Satellites *Annals of the International Geophysical Year* pp 453–473

[42] Details of the information which the Soviet Union wished from observers of its satellite signals (but would not supply to the United States) may be found in Berkner *op cit* p 472 where a notice published in a Soviet Journal *Radio* is reprinted

[43] Jessup and Taubenfeld *Controls for Outer Space* (Columbia University Press New York 1959) especially pp 155–172

[44] Jessup and Taubenfeld *op cit.*, p 187

[45] The International Polar Years of 1882 and 1932

[46] A very able discussion of the pre existing and solid foundation of the IGY is contained in Hugh Odishaw "International Cooperation *International Science and Technology* prototype issue p 28

[47] I am indebted to Professor A P Mitra for an account of the advance in public and official regard for science in India occasioned by the IGY

2

THE US PROGRAM

A PHILOSOPHY FOR COOPERATION

When the formulation of a national space program was under debate in the spring of 1958 the Congressional committees then conducting hearings on the matter were exposed to a remarkable parade of witnesses—generals admirals educators industrialists scientists—who urged almost unanimously that the nation s new space agency should foster international cooperation in the spirit of the International Geophysical Year then at its peak A brief sampling suggests the character and weight of their views [1]

Admiral Rickover who said of space that 'you cannot separate its military aspects from the purely scientific' nevertheless argued that we should take advantage of this new element to help bring about peace to use it as a bridge for peace And he added ' I definitely would be for complete exchange of information in this field with everyone [3] Rear Admiral John T Hayward Assistant Chief of Naval Operations was asked what he thought of the suggestion 'that the United States open its laboratories to scientists from all over the world thus converting the emphasis from space war to a conquest of space and further that the United States should unclassify a great portion of its present material He replied "I agree with that [4] Dr Fred Whipple Harvard College Observatory said I feel that this National Astronautics Agency can indeed cover many of the functions of the IGY and its seems to me that some of the research we are doing in the IGY should be continued in the space studies by our National Astronautics Agency "[5]

Krafft Ehricke, Convair Corp San Diego California, made this statement

> President Eisenhower has repeatedly emphasized this country's desire to join with other nations in the peaceful exploration and utilization of space When Russia had the sole lead in spacecraft Mr Khrushchev proposed a race into space I believe the Soviets have missed a fine opportunity here of showing that they are willing to utilize new areas of human exploration for cooperation I think now that we are a spacegoing nation also we should take a better approach and through our civilian space agency when it is established invite other nations into a cooperative effort in this matter [6]

Dr Lee A DuBridge President California Institute of Technology said I would like to urge then again the creation of a civilian space agency to do the civilian space exploration to collaborate with other nations on international scientific exploration of space and to take care of all of those aspects of space exploration which do not have direct and immediate military applications [7] Later he added We should take the lead as the President has done in proposing international collaboration in peaceful satellite and space exploration [8]

Dr James Van Allen State University of Iowa who was that same week to announce his discovery of the radiation belts surrounding the earth and now bearing his name said Mr Chairman may I remark that one special feature of civilian management in the United States is that it provides immediate possibilities for international cooperation For example at the present time we have IGY satellite observing stations distributed over the world in at least twenty countries Both practically and diplomatically this is a very fine undertaking but it is not at all clear how such arrangements can be managed if space is a military undertaking I think it is rather difficult to imagine let us say the United States Air Force and the Soviet Air Force collaborating on any undertaking but I can easily imagine our national space establishment collaborating with the corresponding civilian establishment in Russia for mutual benefit and with the other countries involved in the IGY [9] Indeed it was the official po i

tion of the Department of Defense that the so called pure scientific information should be made generally available in the exchange of ideas and information to stimulate overall progress in the basic sciences [10]

Moved perhaps equally by the captivating character of the IGY and the pervading hope that an extension of the cold war into space might yet be avoided the Congress did indeed stamp the u age of the IGY upon the new legislation And so it was that the National Aero nautics and Space Act provided that the space activities of the United States shall be conducted so as to contribute materially to cooperation by the United States with other nations and groups of nations in work done pursuant to this act and the peaceful applica tion of the re ults thereof [11]

The linkage was not surpri ing As we have already seen the space age was itself born out of the IGY and the United States and Soviet programs followed announcements by both nations that they would contribute their first satellite launchings to the IGY Yet the space program had been the least successful of IGY s cooperative enter prises One might argue that the Congress objective may have been a purely notional one or that it may not have been informed of the actual limitations which attached to IGY *space* activities But in either case the American action and the projects which later followed from it furnish perhaps the most significant evidence of the indirect effectiveness of the IGY far more significant than the direct political values often attributed to it

The bill to create a new civilian agency for the purpo e of achiev ing national leadership in space in a framework of peaceful purpo es and international cooperation was signed into law by President Eisenhower on July 29 1958 He made one ub tantive comment He took note of the fact that Section 205 of the Act says that the new agency "may" enter into cooperative agreements with the advice and consent of the Senate this he said was a permi ive provision al lowing the space agency to seek Senate advice and con ent where this was appropriate but not precluding executive agreements without recourse to the Senate Eisenhower ob erved that to interpret Secti n

205 otherwise would be to raise serious constitutional questions[12] This interpretation had practical and philosophical implications for the future cooperative program of the new agency Its pace was to be faster and its procedures far simpler than would otherwise have been the case NASA s international program was thus immediately dis tinguished from that of the Atomic Energy Commission which under its legislation was required to obtain approval of its international efforts from the Congress

The civilian character and international mission of the Atomic Energy Commission were however important ingredients in the mix of considerations before the Congress and later the Space Agency in determining the shape and character of the space program The Atomic Energy Act of 1954 was probably the first major govern mental deci ion in history consciously to employ science on a broad scale to foster international understanding[13] The programs which followed from the Act s declared policy to encourage international cooperation in the peaceful uses of atomic energy included over 50 bilateral agreements between the United States and other countries and contributed to the e tabli hment of an international atomic energy authority Reviewed after five years for the Joint Congres sional Committee on Atomic Energy the e experiments with inter national cooperation in the development of the peaceful uses of atomic energy did not appear to have been uniformly succe sful[14] Great expectations had been raised but realization was slow and dis appointing The principal difficulty of course was that after the trumpets blared and the curtain went up the star of the show eco nomical nuclear power failed to appear on the stage An Inter national Atomic Energy Agency (IAEA) had been established but it had few takers for its wares and East West frictions frustrated its enterpri es The peaceful u es of the atom had not yet brought a rapprochement between the Ea t and the West and there was no sig nificant diversion of activities or materials from military to peaceful u es Perhaps most serious for the ultimate objectives of the program domestic authorities and the press had been more successful in con vincing Americans of the nation s genero ity with the secrets of

project by project basis The space agency therefore declined to enter into open ended programs promising collaboration of an undefined character This precluded generalized international agreements which might mean different things to different people and whose imple mentation might prove controversial or impractical

NASA was soon forced to establish criteria for the recognition of foreign agencies with which to deal in cooperative space projects *For it became quickly apparent that internal struggles were under* way in most interested countries to determine which agencies would obtain control of space planning and operations Engineer based groups contested the matter with science based groups and military with civilian and industrial Certainly NASA would not wish to become embroiled in this process or be u ed by any of the contest ants Basic to the answer was NASA s own character as a civilian agency who e international activities were intended to demonstrate the peaceful purpose of the United States in space re earch and ex ploration It was virtually axiomatic that the agency s space activi ties abroad should be conducted with authorities of the same stamp It was obvious too that government sponsorship would be necessary abroad as here to ensure the necessary funds and facilities Accord ingly interested countries were asked to designate a central civilian and government sponsored if not governmental authority to deal with NASA

It was further necessary because of the high technical content of space projects that NASA should be able to deal directly with the central agency designated for that purpose by the cooperating coun try In this matter the Department of State cooperated generously and sympathetically No difficulty was encountered in providing that the task of negotiation should fall to the technical agency but that it should be carried out with the full knowledge and concurrence of the diplomatic authority in order to assure consistency with relevant foreign policy considerations [16]

How much guidance or direction was to be given to cooperating countries many of which inquired about the paths to follow in the early stages of their thinking on space activity? Maximum independ

consultation between NASA advisors and National Academy delegates and staff produced the first public statement of NASA's desire to enter into cooperative projects with other countries[18] COSPAR served essentially as a means for communicating this offer to the national members The heart of the NASA offer was the following

The United States will support COSPAR by undertaking the launching of suitable and worthy experiments proposed by scientists of other countries This can be done by sending into space either single experiments as part of a larger payload or groups of experiments comprising complete payloads'[19]

The full text of this offer was so specific and tangible in character that it could not be shrugged off as a token gesture Nor was its potential lost upon the practicing scientists present for British and Canadian delegates wasted little time in putting into motion the numerous domestic actions required to place themselves in a position to take advantage of it Soviet delegates present made no move either to recognize or match the US action[20]

The immediate effects of the US proposal appeared to be these The future of international cooperation in space exploration was raised at a stroke from the token to the real The character of COSPAR as a meaningful forum—important to attend constructive in facilitating bilateral or multilateral programs going beyond COSPAR's own scope—was also considerably enhanced A new flexibility was introduced into COSPAR permitting those nations so desiring to proceed beyond the limits set by the least forthcoming member Finally the intrusion of politics[21] into the meeting was countered in some degree by this purely technical proposal of an inherently generous character without strings The use of COSPAR for introduction of the US program further recognized its unique role as convener of precisely those individuals and national agencies best situated to motivate a positive response by their governments—even though COSPAR was not itself a governmental body

(It has been pointed out that in the nuclear field the scientific community as such was not utilized in generating an international program Rather a special international governmental authority was

eventually established for the express purpose of facilitating international collaboration the International Atomic Energy Authority[22] Of course special considerations attached to the transfer and handling of nuclear fuels and radioisotopes but it remains an interesting question for speculation as to what might have been the character and course of cooperation in the nuclear field had scientific channels rather than a political structure such as the IAEA been utilized)

Because each potential cooperator faced the considerable task of organizing support at home in order to take up the US offer it was necessary to remain patient and further to confirm and emphasize the US position In September 1959 NASA officials spent a month in Europe meeting with the potential leaders of space activities repeating the message given to COSPAR and painstakingly spelling out the governing philosophy The possibility of assistance in placing experiments in space had been bruited about though often in garbled form Throughout the special community of interest individuals and organizations sought to determine from the NASA representatives what the precise limits of collaboration might be In this process it became quite obvious that past involvement in very different American programs disposed some of the prospective collaborators to expect financial support for quite ill defined projects It was also apparent as had been correctly anticipated by Dr Hugh Dryden, NASA Deputy Administrator that the multiplicity of interests in space was already giving rise to significant competition for primacy within certain countries In this competition an appearance of support by NASA could become a valuable asset

The hopes for financial support and the competition for NASA endorsement were both easily met by the principle of substantive cooperation without exchange of funds and the requirement for a single civilian authority to deal with in each country These points required repetition over and over in an almost wearisome refrain To have departed from these limiting rules during the early and fallow period in order to get things moving a bit faster and thus demonstrate progress may have seemed a great temptation But it is certain that artificially aided projects would have proceeded with

insufficient thought and preparation, as well as resources, in many cases and that the effort to organize for space programs would have been complicated and retarded

The conversations in the Fall of 1959 began at Aachen on the occasion of an AGARD [3] meeting there were carried forward elsewhere in Germany in France and in Italy but opportunity for discussion with scientists of many other countries was also had At this stage there was little idea in Europe as to the projects that might be advanced for cooperation with NASA (One exception discussions in Aachen with officials of the French Centre National d Etudes Telecommunications led ultimately if through several stages of development to a joint satellite project between NASA and a French space agency then not yet in existence) Advice was sought by many but Dr Dryden again demonstrating deep wisdom responded generally that it would make little sense for foreign scientists to direct them elves to projects of particular interest to the United States At the very beginning of the art in Europe such projects might be wholly artificial, imposed upon a scientific community which might be neither prepared nor motivated for them Instead European scientists were advi ed to review their space related talents and interests and to consider which of these they wished to develop toward propo als which might then be of mutual interest Thus a sound basis was established for expre sion of the peculiar talents and interests of an entirely competent scientific community drawing on its own traditions and capabilities

The general pattern of these conversations was repeated at the next COSPAR meeting in Nice in January 1960 [4] broadening beyond the European field to include Japan Latin America and still other communities and on an increasing scale and frequency at sub equent meetings of COSPAR at annual meetings of the International A tronautical Federation and in the cour e of numerous foreign visitations to NASA headquarters in Washington D C Slowly re ult began to materialize More and more countries establi hed national space committees for the planning and coordination of new and exi ting capabilities for the conduct of space re earch (Nowhere was an inte

grated operating agency established as in the United States) The dominant characteristics of these new committees generally estab lished in close relation hip to the principal national scientific bodies may be attributed in some part to a desire to fit the conditions for cooperation with the United States Complementing the formal crea tion of the necessary bureaucratic machinery there developed the first cooperative projects for operational flight programs with the United States

COOPERATIVE PROJECTS

There is relatively little awareness today of the extent to which space cooperation has already developed Cooperation has in fact been ex tended to (1) the launching by the US of atellites prepared by scientists of other nations (2) the competitive selection of individual experiments submitted by foreign scientists of other nations for in clu ion in large US satellites (3) joint sounding rocket projects—utilizing small (non orbiting) rockets to carry out a variety of ex periments high in the atmosphere (4) ground based activity overseas in connection with orbiting experiments in satellite communications meteorology ionospheric research and other fields (5) accommo dation and often joint operation of major US tracking and data acquisition facilities oversea and (6) research and training arrange ments to assist personnel of cooperating nations to gain technical competence necessary *for* cooperation More recently some very limited initial steps have been taken in the direction of cooperation via commercial exchanges in a more sensitive area of space research the development of large space rockets[25]

It has already proved po sible then to extend international co-operation to virtually all aspects of the national space program al though an analysis of the total li t of cooperative projects published semi annually by NASA[26] indicates that emphasis has been placed upon cientific projects rather than on the development of space technology Yet an oversimplified di tinction between cience and technology is to be avoided The intimate working and training rela

tionships required to implement many, if not most of NASA's co operative projects with other countries extend necessarily to the instrumentation directly and indirectly used to conduct experiments Broadly speaking this includes spacecraft (satellite) technology, payload instrumentation data reporting systems (telemetry), ground equipments for receiving data for tracking and so forth Rocket booster technology on the other hand is hedged about by the re strictions which derive from the involvement of such technology in military programs

The joint projects worked out in the course of NASA's interna tional programs deserve some description necessarily limited here to a few examples As we have seen the first projects invited by NASA were satellite experiments which might be prepared abroad for launching from the United States In London Professor (now Sir) Harrie Massey pressed the Royal Society to take up the invita tion extended on behalf of NASA in 1959 In close collaboration with the government of the United Kingdom the Royal Society established a British National Space Committee under Professor Massey with the responsibility for preparing proposals to be submitted to NASA Drawing from the experience of British scientists in the use of small and large sounding rockets in vertical probing of the earth's atmos phere during the International Geophysical Year and before a pro gram for three cooperative satellite projects was presented to NASA during the summer of 1959 Since it requires roughly two years to prepare a small satellite the program would necessarily extend over a period of years possibly beyond the tenure of the agency officials involved Accordingly the agreement was placed on a government to government basis—that [illegible] it was ultimately confirmed in an ex change of notes between the British Foreign Office and the US Department of State

The basic agreement was quite simple It noted the joint desire of the two countries to engage in cooperation in space research pro vided for three satellite projects designated the British National Space Committee and NASA as the cooperating agencies and [illegible] implementation to them (Subsequent agreements with other [illegible]

were more detailed than was this prototype in specifying the respec tive responsibilities of the two sides)

Implementation of the agreement began with the establishment of a Joint Working Group including the British scientists who were to prepare the in trumentation necessary for their experimental objec tives and the American project engineers, who were to engineer the satellite structure and electronics (By the time development of the third British satellite was undertaken the United Kingdom was ready to assume full responsibility for the satellite including its engineer ing and power and telemetry subsystems in addition to the direct instrumentation of its experiments) The importance of the Joint Working Group is easily overlooked It must be understood as an intimate association of project personnel at the working level from both sides Collectively it bore responsibility for successfully carry ing out the thousands of tasks which ultimately produce a total satel lite and launcher system to be directed into space carry out its intricate functions perfectly bring new information to the experi menters and reflect credit on the participants The infinite detail of these myriad tasks was fully laid out before the Joint Working Group for its consideration, for the identification of problems the determi nation of solutions and the implementation of decisions Here was the heart of the cooperative enterprise in a substantive project Here was the close contact the mutual dependence and assistance the give and take which alone could engender the intangible benefits of working together "[8]

Named *Ariel* by the British this first international satellite was launched in April 1962 from a NASA pad at Cape Canaveral[29] It was a complete success combining certain measurements for the first time in one satellite to produce new data of ionospheric effects and conditions[30] The value of the satellite was significantly enhanced by the fact that it happened to be operating during high altitude nuclear tests and so obtained data of the ionospheric effects of these tests (Contrary to many reports, the satellite was not knocked out by these tests while its functions were partially impaired it con tinued to produce useful data until more than two years later)

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Perhaps of equal significance was the fact that the project had been carried out entirely within the framework of the governing philosophy described in the previous chapter The ideas for the experiments had been British the instrumentation was designed funded, and prepared by the British Americans engineered and funded the satellite with its power and telemetry equipment and provided the launching The data was acquired at US and British ground stations turned over to the British and analyzed by them The British experimenters then reported publicly on the results of their own experiments No funds changed hands throughout the exercise

NASA agreements for cooperative launching of thirteen international satellites exist at this writing including four already launched successfully The second international satellite was *Alouette* instrumented and fully engineered in Canada It was launched in September 1962 and is still functioning as the longest lived data gathering satellite to date An exchange of letters between US and Canadian agencies was sufficient to constitute the agreement for this satellite which ultimately cost Canada three to four million dollars plus the cost of special ground stations and data reduction The concept for the *Alouette* experiment was regarded as more advanced and interesting than an existing American plan for the same purpose (*Alouette* was designed to sound the ionosphere from above by means of radio impulses sweeping through a range of frequencies and to receive the returning echoes in the satellite *Alouette* was the first satellite to conduct such an investigation of the character of the ionosphere from above)

So successful has been *Alouette* scientifically and technically that the parties agreed in 1963 to enter into a second and far more ambitious series of joint efforts Under a program designated ISIS (for International Satellites for Ionospheric Sounding) Canadian agencies and industry have teamed up to prepare *four* more satellites for *American launching The ISIS series will carry forward a compre*hensive program of ionospheric investigations during a full swing of the regular cycle of solar activity from minimum to maximum a period of about six years Thus the Canadians have voluntarily

assumed a major role in the total ionospheres program of the US National Aeronautics and Space Administration To permit Canada to enter into this program, its Cabinet recommended authorization of an expenditure of some $9 million Here then, is an example of an initial cooperative program so successful and rewarding that it has led to a second generation cooperation in which an already planned program is extensively shared

A second British and third international satellite *Ariel* II was successfully launched by NASA in March 1964 The third UK effort, scheduled for 1966 will be fully engineered by the British.

The remaining cooperative satellites already brought under agreement are at this writing prospective (See Table I) In each the total experimental flight package has been conceived and designed and will be funded, engineered and tested by the foreign cooperating agency The French program will constitute another unique contribution to the NASA ionospheric research effort The Italian program is of unusual public and technical interest since it calls for the launching of a satellite at sea directly into an orbit in the equatorial plane For this purpose, the Italian National Space Commission has obtained and modified platforms normally used for oil drilling and vaguely resembling 'Texas Towers" except that they are towable. The platforms will be towed to a suitable location in extraterritorial waters on the equator, probably off the east coast of Africa their retractable legs will be lowered to the ocean bottom and securely anchored and the satellite launching will then proceed [31]

Of special international interest is the satellite agreement with the European Space Research Organization [32] Under this agreement, NASA will launch two satellites which have been proposed by this organization of European governments The satellites will be engineered by European industry supervised by a new regional laboratory The data obtained will be forwarded to a new regional center in Darmstadt for analysis

The preparation of a satellite is a considerable project requiring two or more years and up to several million dollars for its completion. The US international program would have been severely limited

TABLE I

COOPERATIVE SATELLITE PROJECTS

Country Name Launch Site & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenters	Experiment Description
Canada • Alouette Pacific Missile Range *Sept 29 1962*	Thor Agena B Near Polar 80 Circular 1000 KM	DRTE	Canadian Telecommunications Establishment (DRTE)	Sound ionosphere *from* above (Topside Sounder) to measure hour to hour electron densities of ionosphere. *Determine* electron density at height of satellite *Monitor* VLF Noise in Range of 1 to 10 KC/s
			Canadian National Research *Council* (NRC)	Measure primary *cosmic ray* particles outside the earth s atmosphere.
• Alouette II Pacific Missile Range 1965	Thor Agena B Near Polar Apogee 2500–3000 KM Perigee 500 KM	DRTE	DRTE and NRC Goddard Space Flight Center (GSFC)	*Same* Canadian experiments as Alouette Determine electron temperature in vicinity of orbiting spacecraft.
• Isis-1 (International Satellite for Ionosphere Studies) 1967	Improved Delta Near Polar Apogee 3500 KM ± 1000 KM	DRTE	DRTE	Swept and fixed frequency topside sounders *supplemented* by eight additional experiments three Canadian and five U S

• Isis 2	Improved Delta Near Polar Apogee at least 2000 KM	DRTE	DRTE, NRC, and NASA Funded U.S. Experimenters	Topside Sounder plus other experiments to be determined.
• Isis 3	Improved Delta To be determined	DRTE	To be determined	To be determined.
France				
• FR 1 Pacific Missile Range Early 1965	Scout Near Polar Circular 800 KM	National Center for Space Studies (CNES)	National Center for Telecommunications Studies (CNET)	Simultaneously measure the electric and magnetic components of very low frequency (VLF) radio emissions and measure electron densities.
Italy				
• Project San Marco" Towable Platform In Indian Ocean Equatorial Waters 1966 or 1967	Scout Inclination 0–3 Near Circular 250–300 KM	Italian Space Commission	School of Aerospace Engineering University of Rome University of Florence	Determine local density of equatorial upper atmosphere by measuring the instantaneous aerodynamic drag on the satellite Ionospheric propagation studies (Faraday Rotation Technique) using beacon.

Preliminary Stages of Program:

(1) Principal elements of the satellite payload have been flight tested by Shotput sounding rockets from Wallops Island (5/63 and 8/63)

(2) A prototype satellite was launched by a scout vehicle from Wallops [illegible]

TABLE I (*Continued*)

Country Name Launch Site & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenters	Experiment Description
United Kingdom				
• Ariel I	Delta	GSFC	Imperial College London	Measure spectrum of energies of primary *cosmic rays* and its variations, with Cerenkov detector
Atlantic Missile Range	Inclination 54 Apogee 1200 KM Perigee 400 KM		University of Birmingham	Measure local electron density with RF impedance probe.
April 26 1962			University College, London	Measure electron temperature and density with *Langmuir probe.*
				Measure ion mass composition and temperature with mass spectrometer
				Measure energy spectrum of solar hard X Rays.
				Measure solar ultra violet emissions (Lyman Alpha)
• Ariel II	Scout	GSFC	Meteorological Office U K. Air Ministry	Measure atmospheric ozone with filtered photocells and spectrometer
Wallops Island	Inclination 51 Apogee 1350 KM			

March 27 1964	Perigee 290 KM		Mullard Radio Astronomy Observatory University of Cambridge	Measure galactic radio noise.
			Nuffield Radio Astronomy Labora tories, Jodrell Bank	Measure micrometeoroid flux by opti cal detection of holes formed in a thin metallic film
• UK Satellite #3 (S-53) Wallops Island Late 1966	Scout Inclination 60 Circular 550 KM	Royal Aircraft Establishment, Farnborough	Meteorological Office, U.K. Air Ministry	Measure vertical distribution of mo- lecular oxygen in earth's atmosphere.
			Millard Radio Astronomy Observatory University of Cambridge	Measure large scale noise sources in galaxy
			University of Sheffield	Measure intensity of VLF radiation.
			Radio Research Station Slough	Measure intensity and geographical distribution of sources of natural ter restrial noise.
			University of Birmingham	Measure electron density and temper ature.

TABLE 1 (*Continued*)

Country Name *Launch Site & Date*	Vehicle *& Orbit*	*Spacecraft Responsibility*		Experimenters	Experiment Description
European Space Research Organization (ESRO)					
• ESRO I	Scout	ESRO	Denmark	Technical University	Study high latitude particles and their effects on the ionosphere including optical heating ionization and large scale dynamic effects involving currents and magnetic perturbations. Satellite also to carry beacon for measuring total electron content between satellite and ground observers
Pacific Missile Range	Near Polar Eccentric		France	University of Paris	
1967			Norway	University of Oslo	
			Sweden	Kiruna Geophysical Observatory	
			U.K.	Queen's University (Belfast)	
			U.K.	Radio Research Station (Slough)	
			U.K.	University College (London)	
• ESRO II	Scout	ESRO	France	Saclay Center for Nuclear Physics	Measure solar and cosmic radiations including X Rays, HE II line Lyman Alpha trapped radiation solar and Van Allen Belt protons, cosmic ray protons, alpha particles and high-energy electrons
Pacific Missile Range	Near Polar Eccentric		Netherlands	Sterrewacht (Ultrecht)	
1967			U.K.	Imperial College (London)	
			U.K.	University College (London)	
			U.K.	University of Leeds	
			U.K.	University of Leicester	

TABLE 1 (*Continued*)

Country Name Launch Site & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenters		Experiment Description
European Space Research Organization (ESRO)					
• ESRO I	Scout	ESRO	Denmark	Technical University	Study high latitude particles and their effects on the ionosphere including optical heating ionization and large scale dynamic effects involving currents and magnetic perturbations. Satellite also to carry beacon for measuring total electron content between satellite and ground observers.
Pacific Missile Range	Near Polar Eccentric		France	University of Paris	
1967			Norway	University of Oslo	
			Sweden	Kiruna Geophysical Observatory	
			U.K.	Queen's University (Belfast)	
			U.K.	Radio Research Station (Slough)	
			U.K.	University College (London)	
• ESRO II	Scout	ESRO	France	Saclay Center for Nuclear Physics	Measure solar and cosmic radiations, including X-Rays HE II line, Lyman Alpha, trapped radiation, solar and Van Allen Belt protons, cosmic ray protons, alpha particles, and high-energy electrons.
Pacific Missile Range	Near Polar Eccentric		Netherlands	Sterrewacht (Utrecht)	
1967			U.K.	Imperial College (London)	
			U.K.	University College (London)	
			U.K.	University of Leeds	
			U.K.	University of Leicester	

TABLE II

FOREIGN EXPERIMENTS ON NASA SATELLITES

Country Name & Date	Vehicle & Orbit	Spacecraft Responsibility	Experimenters	Experiment Description
France Two Experiments				
• Polar Orbiting Geophysical Observatory (OGO–C) 1965	Thrust Augmented Thor Agena Inclination 82–90 Apogee 912 KM Perigee 256 KM	Goddard Space Flight Center (GSFC)	Service D Aeronomie, National Scientific Research Center (CNRS) GSFC (Co-Experimenter)	Measure Airglow at 6300 Å, 5577 Å, 3914 Å, and in the near ultra violet region with photometer
• Orbiting Solar Observatory (OSO–E) 1965	Delta Inclination 33 Circular 480 KM	GSFC	CNRS	Measure self reversal of the Solar Lyman Alpha spectrographic line.
United Kingdom Seven Experiments				
• U S fixed Frequency Top side Sounder (S–48) Summer 1964	Scout Near Polar Apogee 1375 KM Perigee 925 KM	GSFC	University College, London	Measure ion mass composition and temperature with ion mass spectrometer (Similar experiment on Ariel I.)

• Orbiting Astronomical Observatory (OAO-C) 1967	Atlas Agena Inclination 32 Circular 780 KM	GSFC	University of Leicester and University College London	Study the X Ray emission of stars and nebulae and obtain information on the interstellar absorption of HE and the heavier elements.
• Orbiting Solar Ob ervatory (OSO-D) 1965	Delta Inclination 33 Circular 480 KM	GSFC	(1) University of Leicester and University College, London	Measure distribution of total solar X Ray emission over a wide band.
			(2) University College London	Study solar HE II resonance emission (304 Å)
• Orbiting Solar Observatory (OSO-E) 1965	Delta Inclination 33 Circular 480 KM	GSFC	University of Leicester and University College London	Measure solar X Ray flux with spectro-heliograph.
• Direct Measurement Explorer (DME-A) 1965	Thor Agena B Inclination 80 Apogee 2500–3000 KM Perigee 500 KM (Piggyback with Alouette II)	GSFC	University College London	Measure ion mass composition and temperature with spherical ion mass spectrometer (Simila experiment on Ariel I) Measure electron temperature with planar electron temperature probe

TABLE III

COOPERATIVE SOUNDING ROCKET PROJECTS

Country and Cooperating Agency	Number Rocket and Experiment Altitude	Launch Site and Date	Experimenter and Project Description
Argentina			
Argentine National Commission for Space Research (CNIF)	2 Nike Cajun Above 90 KM	Chamical Argentina late 1964	National University of Tucuman Measure D and E region electron *density* and temperature and ion density
Australia			
Department of Supply	4 *Skylark* 200 KM	Woomera Australia *Sept/Nov 1961*	NASA Goddard Space Flight Center Measure stellar and nebular ultra violet radiation *in southern* skies. Compare with northern hemisphere data
Commonwealth Scientific and Industrial Research Organization (CSIRO)	2 *Aerobee* 150 A Above 120 KM	Wallops Island *Apr/May 1963*	Commonwealth Scientific and Industrial Research Organization Measure VLF radio noise in *the ionosphere*
Canada			
Canadian Research Agencies	55 Various U.S (30 per year projected)	Fort Churchill Canada *1958–1963*	Various U S experimenters use Fort Churchill facilities *for* launching sounding rockets in auroral zone to study various atmospheric and ionospheric phenomena.
	6 Black Brant 100 KM	Wallops Island *June/Dec. 1962*	Canadian Research Agencies Determine vehicle flight performance characteristics and obtain engineering data *on* effectiveness of instrumentation. Cosmic Ray sensor and magnetometer included. (Fort Churchill facilities inoperative during this period due to fire damage)

France			
French National Center for Space Research (CNES)	2 *Aerobee 150* Above 280 KM	Wallops Island *Oct 1963*	National Center for Telecommunications Studies (CNET) Study irregularities *in the ionosphere through* simultaneous measurements of VLF field strength and local electron density
	2 French Dragon 2 French Centaure	Hammaguir Algeria *April 1964*	CNES-NASA Goddard Space Flight Center Simultaneously measure charged particle and neutral gas temperatures in the ionosphere.
Germany			
Ministry for Scientific Research	1 Aerobee 150 A	White Sands N M late 1964	Max Planck Institute for Nuclear Physics and NASA AMES Research Center German scientists provide special sampling surfaces to be used in project luster in which lunar dust particles will be sampled directly
India			
Indian National Committee for Space Research (INCOSPAR) of the Department of Atomic Energy	4 Nike-Apache 150 KM	Thumba India *Nov., 1963* *Jan. 1964*	Physical Research Laboratory Ahmedabad Measure upper atmosphere winds by ground photography of illuminated sodium vapor released from rocket
	4 Nike-Apache 150 KM	Thumba, India *Jan. 1964*	University of New Hampshire Investigate the equatorial electrojet at the geomagnetic equator by means of magnetometer instrumentation
	30 Judi Dart	Thumba India 1964	INCOSPAR Meteorological rocket soundings (CHAFF) supplementing the Indian Ocean expedition

TABLE III

COOPERATIVE SOUNDING ROCKET PROJECTS

Country and Cooperating Agency	Number, Rocket and Experiment Altitude	Launch Site and Date	Experimenter and Project Description
Argentina			
Argentine National Commission for Space Research (CNIE)	2 Nike Cajun Above 90 KM	Chamical Argentina late 1964	National University of Tucuman Measure D and E region electron density and temperature and ion den ity
Australia			
Department of Supply	4 Skylark 200 KM	Woomera Australia *Sept /Nov 1961*	NASA Goddard Space Flight Center Mea ure stellar and nebular ultra violet radiation in southern skies. Compare with northern hemisphere data
Commonwealth Scientific and Industrial Re earch Organization (CSIRO)	2 Aerobee 150 A Above 120 KM	Wallops Island *Apr /May 1963*	Commonwealth Scientific and Industrial Research Organization Measure VLF radio noise in the iono phere
Canada			
Canadian Research Agencies	55 Various U S (30 per year projected)	Fort Churchill Canada *1958–1963*	Various U S experimenters use Fort Churchill facilities for launching sounding rockets in auroral zone to tudy various atmospheric and ionospheric phenomena.
	6 Black Brant 100 KM	Wallops Island *June/Dec 1962*	Canadian Research Agencies Determine vehicle flight performance characteristics and obtain engineering data on effectiveness of instrumentation Co mic Ray sensor and magnetometer included. (Fort Churchill facilities inoperative during this period due to fire damage)

France *French National Center for Space Research (CNES)*	2 Aerobee 150 Above 280 KM	Wallops Island *Oct 1963*	National Center for Telecommunications Studies (CNET) Study irregularities in the ionosphere through simultaneous *measurements of* VLF field strength and local electron density
	2 French Dragon 2 French Centaure	Hammaguir Algeria *April 1964*	CNES NASA Goddard Space Flight Center Simultaneously measure charged particle and neutral gas temperatures in the ionosphere.
Germany *Ministry for* Scientific Research	1 Aerobee 150 A	White Sands N M *late 1964*	Max Planck Institute for Nuclear Physics and NASA AMES Research Center German scientists provide special sampling surfaces *to be used in* project luster in which lunar dust particles will be sampled directly
India Indian National Committee for Space Research (INCOSPAR) of the Department of Atomic Energy	4 Nike Apache 150 KM	Thumba India *Nov., 1963* *Jan. 1964*	Physical Research Laboratory Ahmedabad Measure upper atmosphere winds by ground photography of illuminated sodium vapor released from rocket
	4 Nike-Apache 150 KM	Thumba, India *Jan. 1964*	University of New Hampshire Investigate the equatorial electrojet at the *geomagnetic* equator by means of magnetometer instrumentation
	30 Judi Dart	Thumba India 1964	INCOSPAR Meteorological rocket soundings (CHAFF) supplementing the Indian Ocean expedition.

TABLE III (*Continued*)

Country and Cooperating Agency	Number Rocket and Experiment Altitude	Launch Site and Date	Experimenter and Project Description
Italy			
Italian Space Commission	8 Nike Cajun and Nike ASP 80–200 KM	Sardinia *Jan./April/Sept 1961 Dec., 1962*	Italian Space Commission Measure upper atmosphere winds by ground photography of illuminated sodium vapor released from rocket.
Japan			
Japanese Radio Research Laboratories	3 Nike Cajun 100–130 KM	Wallops Island *Apr/May 1962*	Japanese Radio Research Laboratories and NASA Goddard Space Flight Center Combine Japanese swept frequency resonance probe with GSFC Langmuir probe for electron density and temperature determination.
	2 Aerobee 150 A Above 130 KM	Wallops Island *Sept., 1963*	
	1 Javelin Above 200 KM	Wallops Island 1964	
New Zealand			
New Zealand National Research Committee	1 Arcas 70–80 KM	Birdling's Flat, N.Z. *May 1963*	University of Canterbury New Zealand Measure wind drift and turbulent diffusion in the mesosphere by ground based photography of illuminated aerosol released from rocket. Correlate data with low frequency radio scattering
	2 Arcas 70–80 KM	Birdling's Flat N.Z. 1964	

Norway/Denmark			
Norwegian Committee for Space Research *Royal Technical* University of Denmark	1 Nike-Cajun 1 Nike-Apache 2 Nike-Cajun *Above 90 KM* 3 Nike Cajun 1 Nike Apache 3 Nike Apache *Above 90 KM*	Wallops Island *Dec 1961* *June 1962* *Mar/Apr 1963* Andoya Norway *Aug/Dec 1962* *Sept 1963* *March 1964*	NASA GSFC with Norwegian participation (Wallops launchings) Norwegian Defense Research Establishment and Royal Technical University of Denmark (Andoya Launchings) Measure D and E region electron and ion density and electron *collision frequency by* radio absorption experiment, Faraday Rotation Experiment and RF Impedance and Conductivity Probes. Lyman Alpha monitor (Wallops) and energetic particles experiment (Andoya) also included
Pakistan			
Pakistan Upper Atmosphere and Space Research Committee	2 Nike-Cajun 125 KM	Sonmiani Beach Pakistan *June 1962*	Pakistan Upper Atmosphere and Space Research Committee Measure upper atmo phere winds by ground based photography of illuminated sodium vapor released from payload
	1 Nike-Cajun 80–125 KM	Sonmiani Beach *May 1963*	
	2 Nike-Apache 125–200 KM	Sonmiani Beach *April 1964*	
	16 Judi Dart	Sonmiani Beach 1964	Pakistan Upper Atmosphere and Space Research Committee *Meteorological rocket soundings (CHAFF) supplementing* the International Indian Ocean Expedition.

understanding of the peculiar meteorology of the Indian Ocean basin —a problem requiring synchronized soundings in which they are cooperating

Why should countries with other immediate needs enter into the esoterica of space research? It was reasonable enough to conclude that countries should certainly not be pressed to divert energies and resources to space activity The decision to do so must be their own and NASA s requirement that they do so without financial aid en sured that the decision would be made on the merits Even so why should that decision be made in the affirmative? A chief science advisor of the Pakistani government Professor Abdus Salaam a widely known physicist who spends much of his time at University College London has supplied an interesting answer To Professor Salaam one of Pakistan s great needs in common with other develop ing countries is to interest her able young people in careers in technology The problem is how to attract enough of them away from the traditional preparation in the classics Because space flight re search is highly visible and carries with it an air of compelling interest, it can help to attract young university people into electronics work materials research meteorology ionospheric studies and so forth Thus a developing country may enter into cooperative sound ing rocket work as well as other space research not because it has grandiose notions of the scope of its eventual participation or con tribution but because the activity is an effective stimulus to tech nological interest study and occupation In this sense one may suggest a small exception to the judgment that The people of the emerging countries have not the means to go shopping in what Pro fessor P M S Blackett has called the Supermarket of Science they cannot even afford the bargain basement

Perhaps as important is this general observation pertinent to scien tific cooperation by developing countries

> Even though indigenous scientific research may be relatively un important as a means of solving technical problems it is important as a means of promoting style and a sense of values of a sci entific world also a developing country gains self confidence if its

> nationals play a part, however modest, in the advancement of science.[34]

Still more direct is a statement by the Chairman of the Indian National Committee for Space Research (INCOSPAR), Dr Vikram Sarabhai, who has kindly allowed me to use it

> It is clear that the economic development of a nation is intimately linked with the understanding and application of science and tech nology by its people It has sometimes been argued that the application of technology by itself can contribute to economic growth This is certainly true as an abstract proposition but fails in practice. Witness the state of development and social structure of countries in the Middle East and Arabia where for decades natural resources have been exploited with the most sophisticated technology History has demonstrated that the real social and eco nomic fruits of technology go to th who apply them through understanding Therefore, a significant number of citizens of every developing country must understand the ways of modern science and of the technology that flows from it. This means the ability to ask the basic question why and where for? This requires train ing involved in probing the frontiers of science whatever field one may be engaged in whether it is Biology Genetics Atomic Science or Space Research It is obviously necessary for each country to provide facilities for its nationals to do front rank research within the resources which are available It is equally necessary having produced the men who can do research to organize task-oriented projects for the nation s practical problems Pursuit of cosmic rays and space research does not require an apology in a developing nation provided the activities are within a total scheme of priorities in the allocation of national resources Many of us who are engaged in pure science are also involved in the organization and conduct of education, of planning and of industrial development in fields such as electronics and chemicals I am actively interested in the application of science for the im provement of agricultural productivity and in the implications of science to society and the problems of security[35]

Sounding rocket programs have grown to the point where a signifi cant percentage of NASA s own projects are carried out in the co operative category, perhaps one third per year and the proportion may well grow Much of the activity is conducted at overseas launch ing sites prepared entirely by the foreign participants often because of geographic factors of special interest for scientific research

A particularly interesting example of a cooperative effort in this category with far reaching implications is the case of the sounding rocket range at Thumba in India The fir t objective here was a modest bilateral cooperative sounding rocket project between NASA and the India Committee for Space Research (INCOSPAR) The suggestion was then made to Dr Vikram Sarabhai, Chairman of INCOSPAR, that the range be offered for use internationally and that UN sponsorship be sought The US then introduced into the Technical Subcommittee of the United Nations Committee on the Peaceful U es of Outer Space a resolution for UN sponsorship of sounding rocket ranges in scientifically critical locations the ranges would be available to member nations interested in using them for open projects The resolution received unanimous support in the UN Subcommittee its parent Committee and ultimately in the General Assembly In the course of this procedure India formally offered its proposed range at Thumba on the geomagnetic equator for sponsorship under the resolution Considerable skill effort and intelligence were devoted to developing the facilities In January 1964 a special committee went out to the range to determine its compliance with the conditions of sponsorship So compelling were the technical and nontechnical reasons for participation in support of the range that the French space agency had already entered into a tripartite project with INCOSPAR and NASA and the Soviet Union had according to the committee s report, begun discu sions with INCOSPAR for a joint sounding rocket effort Both France and the Soviet Union had promised equipments for use in connection with the range It may be assumed that the United Kingdom and other countries also are interested in a ociating themselves with the range Thus what began as a bilateral effort with relatively narrow technical objectives has grown throu h a process of inexorable technical and political appeal to the point where major nations including the Soviet Union find it important to join in The result is the first activity in which technicians of ea t and west may actually meet in the context of spa e flight programs and operations—which must be open to all

No mere exchange of data or personnel could exercise a comparable

effect. The compelling force of the Indian program derives from its substantive character—from the physical e_tablishment of a range in a region of strong scientific interest, its outfitting with neces ary equipments the planning and conduct of actual flight projects and the tangible participation of two or more nations Unquestionably, too the element of UN sponsor hip contributed significantly to the stature of the project and the attractivene s of membership Also important was the fact hat an unequivocal set of requirements for "joining the club was established one that could not be met by lofty sentiments alone

The fourth category of NASA s cooperative international programs enlists still broader participation and contribution abroad In this category there is no joint effort in experiments destined for space flight in satellites or sounding rockets Here the participation is essentially ground based, it consists of activities that suitably equipped scientists can carry out in more or less conventional ways virtually anywhere in the world in order to complement enhance indeed make possible NASA s own satellite experiments Perhaps the be_t example is the cooperation that made possible the first trans atlantic television broadcasts by satellite In this case NASA required elaborate overseas ground stations capable of handling TV and other radio tests which would be transmitted over the Atlantic Ocean by satellite It was possible to request permission to build a US station in Europe for this purpose Instead it was decided to offer the com munications agencies of England and France an opportunity to participate in the experimental program for demonstrating the feasi bility of communications satellites their price of admission so to speak was the erection of suitable ground stations at their own ex pense Both countries readily as ented[36] Almost immediately other nations asked to participate and were welcomed in every case on the same terms The total number eventually rose to eleven each country making its own arrangements for a suitable ground facility the cost ranging from less than one million dollars to something close to ten million dollars depending upon the character and capability of the instrumentation A valuable aspect of the project was the establish

ment of an International Ground Station Committee composed of representatives of all the cooperating international agencies and the NASA contractors under NASA chairmanship This Committee provided an expert forum for the selection of suitable radio frequencies, the definition and scheduling of transmissions tests and consideration of the interests of each and all of the participants The program was completely successful and had considerable impact in demonstrating to the world the technical promise of communications satellites. Moreover it testified to the sincerity of US advocacy of global cooperation in the establishment of a commercial system of communications founded on satellites (It is of some interest that the Soviet Union was later invited to participate in this multilateral communications satellite testing program by correspondence from President Kennedy to Chairman Khrushchev The Soviet Union was negative to this proposal)

Little noted but no less important was a second "ground based" project of global cooperation Recognizing the intense interest in many areas of the world in improved weather forecasting and research NASA sought and obtained partnership of the US Weather Bureau in "internationalizing" NASA's TIROS weather satellites Member countries of the World Meteorological Organization over one hundred were invited to conduct special observations of local cloud cover using aircraft balloons special cameras and other conventional techniques these observations were synchronized with the passes overhead of the TIROS satellites which photographed cloud cover on a much larger scale and from a great altitude Over 35 countries participated in this effort laying a basis for interpreting the new satellite weather data in terms of observed local conditions As in all of NASA's programs these projects went forward without financial assistance from the United States NASA and the US Weather Bureau then invited the participants to attend an International Workshop in Washington on the use of weather satellite data for research and forecasting[37] There were strong doubts that foreign meteorologists would attend the Workshop without financial assistance yet they did attend from 30 countries including some of the

smaller African and Caribbean nations, making this a very rare type of international conference in the United States, indeed

Other forms of ground ba ed cooperation have been organized (See Table IV) These generally involve foreign scientists in making various measurements or ob ervations in order to assess local con ditions or phenomena complementing the data recorded by satellites in their immediate environment In some cases such observations are indispen able for the total success of an experiment This form of cooperation is generally established through correspondence without formality, although national space authorities are informed and con sulted in the organizing process

Undergirding all of NASA s international cooperative activity is a variety of opportunities for training If countries new to space research are to enter into meaningful projects some such training and orientation is required For this purpose NASA offers a three faceted program To permit foreign graduate tudents to advance their specific competence in the field NASA established a fellowship program in US universities[38] Consistent with its basic philosophy NASA meets only the university costs and travel in the United States an appropriate agency abroad must sponsor the student and provide for his travel to and subsistence in this country Thus the sponsoring agency is motivated to consider carefully its participation in the pro gram its election of trainees and perhaps most important its plans for future utilization of the trained personnel If such costs deter a country from arranging for training for its young students obviously it cannot mount a space effort of enough consequence to employ the finished trainee

A second program provides for more specific training where re quired for immediate participation in cooperative projects which have been already defined and agreed In this case the training is done at NASA field centers where work similar to that entailed in the joint effort goes on This may involve training in small rocket launch ing tracking payload design and preparation processing and anal ysis of data and so forth The length of training depends in part on the particular subject matter, but if laboratory training is required

TABLE IV

COOPERATIVE GROUND BASED PROJECTS

Project	International Participation

• *Meteorological Satellites*

TIROS (Television and Infrared Observation Satellite) obtains television pictures of cloud formations and patterns and measures the absorption and reflections of infrared solar radiation by the earth and its atmosphere

Name	Launch Date	Nominal Orbits Inclination	Circular
TIROS I	*4-01-60*	48	700 KM
TIROS II	*11-23-60*	48	700 KM
TIROS III	*7-12-61*	48	700 KM
TIROS IV	*2-08-62*	48	700 KM
TIROS V	*6-19-62*	58	7_0 KM
TIROS VI	*9-18-62*	58	690 KM
TIROS VII	*6-19-63*	58	660 KM
TIROS VIII	*12-21-63*	58	425 KM

International Participation:

NASA and the U S Weather Bureau have provided an opportunity for two types of direct foreign participation in weather satellite operation

(1) Foreign weather services were invited to perform ground based observations synchronized with satellite photography Some *Forty Weather Services* have taken part in this program using TIROS II through TIROS VIII

(2) The first *Automatic Picture Transmission* (APT) subsystem (launched on TIROS VIII on December 21 1963) provided an opportunity for direct read out of local cloud cover pictures using relatively simple ground equipment Sets purchased in the U S were operated in *France* and at the *IIOE Headquarters* in *India Australia Canada Denmark Hong Kong Indonesia and the U K* U ed equipment designed and built locally based on APT technical data supplied by NASA

• *Communications Satellites*

Projects RELAY TELSTAR and SYNCOM have been designed to determ ne the feasibility of tran oceanic communications via active repeater satellites These satellites pick up and amplify signals received from ground stations and then retransmit them back to earth.

Name	Launch Date	Inclination	Nominal Orbits Apogee	Perigee
TELSTAR I	7-10-62	45	_600 KM	950 KM
RELAY I	12-13-62	47	7425 KM	1320 KM

International Participation:

In 1963 telephone telegram and high speed data communications experiments were conducted among ground stations in the *U.S England, France Italy Japan, Bra il* and *Germany* (the first five stations al o participated in intercontinental television experiments) *Nigeria* participated during this period in project *SYNCOM* by supporting the USNS *Kingsport* in Lagos harbor as the African terminal for this project President Kennedy and Nigerian Prime Minister Balewa formally inaugurated SYNCOM communications directly between North Amer ca and Africa on August 23 1963 by conducting the first live telephone conversation via sat ll te between heads of go ernment In May 1964 *Spain* entered the network by

TELSTAR II	5-0?-63	43	10555 KM	925 KM
SYNCOM II	7-?6-63	32.5	35900 KM	3?791 KM
RELAY II	1-21-64	46.5	7400 KM	2129 KM

conducting narrow b nd e periments w th the U S In the late summer of 1964 *Denmark Norway and Sweden* plan to have a joint facility operational on a *receiving basis. In 1965 Canada* intends *to complete* a ground station capable of conducting narrow band and television experiments

- *Ionosphere Topside Sounder Satellites (Alouette and S-48)*

Alouette uses a swept frequency sounder system and S-48 will use a fixed frequency *system to measure* ionospheric electron density di tribution and study its variations.

Name	*Launch Date*	*Nominal Orbits*	
Alouette	9-?9-62	Near Polar	Circular 100 KM
S-48	1964-65	Near Polar	1375 – 725 KM

In addition to numerous *U S* and Canadian station *twenty three* stations in *fourteen countries* have taken or are taking ground *soundings coordinated* with satellite soundings which permit comparison of top and bottom side ionospheric profiles

The radio research *station of the United Kingdom* department of Scientific and Industrial Research is staffing and operating three telemetry stations *for the acqui* ition of data from NASA Canadian topside sounder satellites The RRS work which includes data reduction and analysis will continue through the ISIS program

- *Ionosphere Beacon and Laser Track ng Satellite (S-66)*

S-66 provides the means for synoptic study of the iono*sphere by ground based observations of radio* ignals transmitted from the satellite and for experiments in satellite *tracking by* laser beams directed to S-66 and returned to ground based receivers by special reflectors

Name	*Launch Date*	*Nominal Orbit*	
S-66	Summer 1964	Near Polar	Circular 1200 KM

Ground stations in *twenty seven* countries currently plan to carry out Faraday rotation scintillation and doppler *differential* experiments in order to measure the integra ed electron den ity in a vertical plane *from the satellite to the ground station below* and its variations as a function of latitude season and diurnal time The *U K and France* plan to participate in the Laser tracking experiment

Brazilian Project RAS4 Three ground tations spanning the geomagnetic equator have been established by the Brazilian Space *Commission* (CNAE) for pecial studies of the equatorial ionosphere using Faraday rotation differential doppler and group delay techniques of analyzing signals from the iono phere beacon (S-66) and other U S satellites

trainees are asked to remain long enough so that they are of some value to the laboratory, in return for the training given. Again they must be fully supported by their sponsoring institutions at home.

A third program offers resident research associateships at certain NASA centers for post-doctoral scientists (citizens or foreign) of recognized achievement. Since the principal benefit of these associateships is to NASA, liberal stipends are provided and the arrangements are entirely individual.[39]

By July 1964 these three programs had brought some 44 graduate fellows, 176 trainees for cooperative projects, and 92 post doctoral associates to the United States. The second program in particular has brought home to NASA centers and their adjacent communities some of the flavor of international cooperation. At NASA's Wallops Island launching site in Virginia, Pakistani and Indian trainees have worked side by side. Townsfolk in the nearby communities have grown accustomed to Moslem visitors who on more than one occasion have approached startled homeowners to ask permission to place a prayer rug on the front lawn at the hour for prayer. The townsfolk have also accepted the fact that Italian technicians training at Wallops are very likely to walk off with their contract bridge prizes. NASA's technical staff have been much intrigued by their international associations and have welcomed them as a source of technical and social enrichment of their own work day.

Some mention should be made, too, of NASA's policy of openness to brief visits by foreign nationals, consistent with the requirements of the Act for such openness and yet within the relatively few constraints imposed by security considerations. Since NASA was established in late 1958, almost nine thousand foreign scientists, technicians, press and industry representatives, and government officials have made visits of an hour to a day to NASA installations, including the launching sites at Cape Kennedy and at Wallops Island, Virginia. (See Table V.)

In all that has been described here so far, NASA has invited and developed its international associations, in order to respond to the Congressional mandate to cooperate as set forth in the National

TABLE V

PERSONNEL EXCHANGES

Program	Purpose	Cumulative Participation	
Resident Research Associateships	Postdoctoral and senior postdoctoral grants for senior foreign scientists administered for NASA by the National Academy of Sciences provide for participation in research at NASA centers for one year	Foreign Nationals from Countries	92 25
International Fellowships	Theoretical and experimental training in the Space Sciences provided to foreign graduate students at U S Universities for one year with possibility of renewal for a second year on a shared cost basis Program administered for NASA by the National Academy of Sciences and designed to contribute to the capabilities of cooperating countries	Fellows from Countries Universities	44 13 20
Technical Training	Technical training available to foreign technicians and scientists at NASA centers in support of agreed cooperative programs and ground facility operations Length of training from several months to one year (Training of tracking station personnel under the direction of Goddard Space Flight Center and the Jet Propulsion Laboratory Other training principally at GSFC, Langley and Wallops Station)	Foreign Nationals from Countries	176 17*
Visits	Officials and scientists from foreign countries visit NASA facilities in program demonstrating open peaceful character of U S civilian space effort and the opportunities it provides for particip tion by other countries	Visitors from Countries	Approx. 8400 95**

* Includes the European Space Research Organization (ESRO)
** Includes ESRO and the European Launcher Development Organization (ELDO)

STATION OPERATION

United States

Joint

Foreign

NASA INTERNATIONAL STATION AGREEMENTS

MANNED FLIGHT



Australia
Bermuda
Canary Is and
Canton Isl nd
Ma. gasy Republi.
Mexico
Nigeria

DEEP SPACE



SCIENTIFIC SATELITE



Australia
Canada
Ch le
Ecuador
E gland
Mal gasy Republic
P ru
South Africa

INJECTION MONITORING



OPTICAL



Argentina
Australia
C racao
Ind a
Ira
Japan
Peru
South Africa
Spain

DATA ACQUISITION



India

the space race, cooperation is not thought meaningful unless and until it embraces the Soviet space program. This viewpoint is superficial and even pernicious If followed to its logical end it would lead us to neglect our friends until we had become friendly with our principal adversary Moreover, this viewpoint overstates the *technical* value of cooperation with the Soviet side while it understates this aspect of collaboration with the other advanced countries Generally speaking, Western Europe is far stronger scientifically and technologically than the USSR and the Western Europeans are rapidly closing in on us If present trends continue it will be only a matter of a few years before they achieve supremacy '[40] Thus we may have more to learn in a basic sense from our friends than from our adversary in the pervading technologies that underlie space research Again in the political arena, the US program of cooperation in space activity reaches a scientific, technical and official elite in the struggle for minds It sets up a highly visible contrast between an open and constructive program on the one hand and a closed self-centered and dimly threatening program on the other The very existence of NASA s cooperative programs operates to nudge the Soviet Union toward a more forthcoming posture in the world Those who have attended meetings of COSPAR and of the United Nations Committee on the Peaceful Uses of Outer Space have witnessed the impact of the recitation by member after member of his country s joint activities with the United States The absence of any counterpoint testifying to Soviet cooperation is inescapable At the June 1963 meeting of COSPAR in Warsaw for example, twenty member countries (excluding the United States and the USSR) reported upon their space activities Of the twenty seventeen referred to substantive programs undertaken with the United States Only three mentioned the Soviet Union one being anticipatory one reporting joint balloon observations, the third merely noting the referral of visual satellite observations to the USSR The US report noted activities involving over sixty other countries (including the USSR) ! The Soviet Union s report mentioned *no* other country![41] One can only assume that there is a pressure here which contributes with other factors to the increasing

efforts of the USSR to assert the disposition and assume the appearance of cooperation In sum our cooperation with other countries has indirect as well as direct technical and political importance

Quite part from its possible impact upon our problems with the USSR the program of cooperative activity which has been described in this chapter has intrinsic values of its own They merit a brief exposition

TANGIBLE BENEFITS

International cooperation as a general good enjoys virtually universal acceptance and support much like motherhood Its values are usually described in the abstract and its benefits are noted under intangibles Unfortunately this leaves the case for cooperation somewhat vague At best it may fail to quiet secret doubts and at worst it may inspire strong cynicism Undoubtedly there *are* intangible benefits to be derived from international cooperation indeed they may in the long run be the most important ones and they should receive most serious consideration But the case for cooperation among the nations is much more persuasive if attention is directed to its practical and tangible benefit (A by product of attention to the practical values may be better cooperative program) At the very least there should be an end to endorsing international collaboration in such generalities as to suggest that nothing more specific exists

We have seen that the very brief history of space research and exploration has already produced a considerable degree of cooperative activity The practical values of this cooperation are scientific and technical operational economic and political At the risk of some repetition of the material in the previous section these values are best demonstrated in terms of the cooperative projects described there

Tangible scientific and technical benefits have been numerous Unique and superior experiments have been introduced into the overall space research effort by foreign contributor Thus the Canadian satellite *Alouette* represented a concept for topside sound

simultaneous launching of sounding rockets from Greenland to Antarctica, or on the day and night sides of the earth or around the periphery of the Indian Ocean basin cannot be done at all without cooperation among the nations The fact that sounding rockets are restricted essentially to vertical sampling of atmospheric and other conditions puts an obvious premium on multiplying and coordinating such vertical profiles in many locations

Even satellite experiments seemingly self-contained may require the participation of scientists in far flung regions using instruments of their own to provide supplementary local observations or indispensable data points for satellite experiments The ionospheric investigations of NASA s S 66 satellite for instance cannot be complete in themselves without the help of scientists equipped with suitable ground instruments in many countries These cooperating scientists observe the satellite s radio emissions as they are affected in the course of their travel to earth through the ionosphere to measure scintillation rotation polarization and other effects thereby supplementing the measurements made by the satellite itself in its own immediate vicinity

Again the initial tests of long distance satellite communications could not of course have so clearly demonstrated the future of this service without the cooperation of British French, and other nations in providing the overseas ground tations for completion of intercontinental transmissions This joint enterprise helped in an indirect way to unite many nations in selecting certain radio frequencies in advance of negotiations conducted on this subject in the International Telecommunications Union s Extraordinary Conference of October 1963 Most important perhaps the program lent substance to the US position that it wished to enter into the commercial exploitation of communications satellite service only on a global basis in partnership with other nations

A final note on the technical benefits To do a thorough job of tracking and acquiring data from its satellites controlling deep space probes and monitoring manned flights NASA has had critical requirements for overseas sites for a complex network of tracking and

sums are insignificant compared even to the space sciences portion of the total US space effort Yet the cost is less to each side than if the program did not exist at all Even more important, there is a base upon which to build as foreign capacity in the space area grows If the momentum of the cooperative program can be maintained the curve of foreign participation and contribution should be an ascending one

It is of some interest that a significant proportion of the total foreign investment occasioned by joint space projects has been expended in the United States Perhaps 45 percent of the total has been spent here Small as it is this sum represents a gold inflow rather than outflow As such it virtually exculpates the international space effort from a criticism commonly lodged against cooperative enterprises—that they dissipate the national treasure without apparent return

On the political side tangibility is more difficult to demonstrate Yet there are grounds for believing that US dedication to peaceful purposes through open programs contributed directly to the successful acquisition of needed space tracking and data retrieval sites in certain areas abroad [43] We know too that the cooperative program has been a common denominator or a catalyst for sentiment in support of US objectives on the subject of outer space in United Nations forums It has without question lent credibility to our posture and contrasted sharply with our competitor s performance in which the language of cooperation has been used with little substance The space program has a further potential for support of US foreign policy objectives in that it lends itself admirably to cooperation with multilateral organizations in Europe buttresses the image of the US as an open society ready to join with all of good will and in particular demonstrates the relative openness of this country with one of its greatest national assets—advanced technology The attractiveness of space research its broad base in national life—for the *space sciences and technologies are deeply rooted in the main* stream of industrial and academic work—carries with it even a healthy potential for inspiring other countries to narrow the tech

nological gap" between themselves and the two leading nations rather than to allow it to grow

The emphasis here upon the tangible benefits of space cooperation —scientific technical economic and political —is not intended to suggest that intangible benefits do not exist or that they are less important The Congressional mandate which prompted NASA s international program was itself stated in terms of the intangibles cooperation in the broad sense peaceful uses and the benefit of all mankind—without distinction between friendly and unfriendly nations and without regard to short term benefit Presidents Eisenhower Kennedy and Johnson have all repeatedly endorsed cooperation in space research in broad terms It is a personal conviction nevertheless that the surest path to greater intangible benefits is through demonstrably useful projects which reassure the participants at any and every point that they are indeed progressing and in the right direction Without such assurance confidence in cooperation cannot grow and we swing painfully and ineffectively from action to reaction from illusion to disillusion

As it stands then the NASA international space program has established for itself a practical philosophy encouraged the development of space activity in nations willing to make contributions of their own provided a basis for practical cooperation with more than half the countries of the world attracted significant contributions to our own ongoing space research and exploration efforts enjoyed a modest but positive balance of payments in so doing and contributed in some degree to the political interests of the United States *and* the cooperating nations

NOTES

[1] This sampling is drawn from *Hearings before the Select Committee on Astronautics and Space Exploration* 85th Congress Second Session on H R 11881 (April 15-18 21-25 28-30 May 1 5 7, 8 12 1958)

[2] *Hearings* p 259

[3] *Hearings* p 260
[4] *Hearings* p 287
[5] *Hearings* p 380
[6] *Hearings* p 617
[7] *Hearings* p 781
[8] *Hearings* p 819
[9] *Hearings* p 871
[10] *Hearings* p 1496
[11] National Aeronautics and Space Act of 1958 Section 201
[12] Statement by President Eisenhower Upon Signing the National Aeronautics and Space Act (July 29 1958) Documents on International Aspects of the Exploration and Use of Outer Space (1954–1962) *Staff Report* prepared for the Committee on Aeronautical and Space Sciences United States Senate 88th Congress 1st Session (May 9 1963) Document No 18
[13] The Atomic Energy Act of 1954 states that it is the policy of the United States that the development use and control of atomic energy shall be directed so as to promote world peace (Chap 1 Sec 1 (b)) In Section 3 the Act states that the policies enunciated shall be effectuated through

> a program to encourage widespread participation in the development and utilization of atomic energy for peaceful purposes a program of international cooperation to promote the common defense and security and to make available to cooperating nations the benefits of peaceful applications of atomic energy and programs with international arrangements and with agreements for cooperation

[14] Robert McKinney *Review of the International Atomic Policies and Programs of the United States* (October 1960) especially pp 55-7?
[15] This discussion and the remainder of the chapter represent an extension of various remarks describing the philosophy of NASA s international program by Dr Hugh L. Dryden Deputy Administrator of NASA particularly in testifying annually on NASA programs before the cognizant Committees of the House and Senate and by the author in various published articles and addresses
[16] In particular those responsible in the Department of State at various times for direct liaison with NASA merit the greatest commendation for their intelligent and sympathetic support of this aspect of NASA s program philosophy Mr Philip A Farley then Special Assistant (to the Secretary of State) for Atomic Energy and Space Matters is so deserving for the first year or more of the program and Mr Robert F Packard Chief Outer Space Affairs Section Office of International Scientific Affairs for the following years
[17] An unpublished analysis prepared by the author early in 1959 for the National Academy of Sciences (which in turn made it available to NASA and the Department of State) discounted an operational role for

the United Nations in space research and exploration at least for the foreseeable future At the conclusion of the first meeting of the United Nations Committee on the Peaceful Uses of Outer Space in March 1962 its chairman Ambassador Maatsch of Austria stated for the record a consensus that the Committee s functions would not be operational in character (*Verbatim Record of Ninth Meeting* March 29 1962)

[18] Dr Homer E Newell then Deputy Director for Space Flight Programs NASA conferred with Dr Richard W Porter the US Academy s Delegate to COSPAR communicated with Dr Hugh L Dryden by telephone from The Hague to Washington then with the assistance of Academy staff principally Dr Hugh Odishaw and the author produced a written statement of NASA s readiness to cooperate The statement was tran mitted to COSPAR by Dr Porter on behalf of NASA

[19] Letter of March 14 1959 from Dr R W Porter to Professor Dr H C Van de Hulst, President Committee on Space Research (COSPAR) The Hague The Netherlands

[20] It is believed that French representatives approached Soviet scientists informally to explore the possibilities of a matching offer from the Soviet Union They were met with noncommittal response and subsequent inaction

[21] See Chapter III

[22] Dr Hugh Odishaw has pointed out this contrast in International Cooperation in Space Science a chapter in *Outer Space* ed by L. Bloomfield for the American Assembly Prentice Hall Inc p 116 Odishaw speaking of the NASA program says

> "One of the most significant aspects of this bilateral government program has been its operation within the non governmental COSPAR framework As in the IGY COSPAR does not undertake to negotiate bilateral arrangements. It does however encourage such arrangements and provides a congenial forum for the discussion of experimental ideas The presentation of such offers within COSPAR in its lf creates an international environment for the expe iment and for the scientists keeping the experimental work that many ensue within an international framework not only for discussion purposes but for the interchange of data and results
>
> The NASA procedure compares favorably to that in the analagous area of atomic energy Although the International Atomic Energy was not established for cooperative scientific efforts, it was authorized largely to assist in application of nuclear energy to conduct the sale of uranium fuel under safeguards as to their possible military diversion, and to develop safety standards. But even before as well as after the agency was established, both the Soviet Union and the United States entered into arrangements for the sale of uranium fuel at costs below those which the Agency could meet arrangements which are wholly bilateral in nature and seriously hamper the ability of IAEA to promote internat onal agreements in atomic energy NASA on the other hand

has endeavored to establish its bilateral arrangements within the international framework or spirit of COSPAR

[23] AGARD is the Advisory Group for Aeronautical Research and Development a committee of NATO It was not involved in the discussions described here the AGARD meeting was simply utilized as a convenient *occasion for these discussions*

[24] Principal officials of NASA participating in these informal discussions were Dr Abe Silverstein then Director of Space Flight Programs, Dr Homer E Newell then his Deputy and the author then Director Office of International Programs

[25] Arnold W Frutkin International Cooperation in Space Research" in *Astronautics and Aerospace Engineering* (March 1963) p 100

[26] International Cooperation in Space a semi annual report of the Office of International Programs National Aeronautics and Space Administration

[27] This exchange of notes was consummated long after the actual initiation of the first UK/US joint satellite project but ensures the continuation of the cooperative effort for its full course Text of the agreement and exchange of notes may be found in US Treaties and Other International Agreements Dept of State Vol 12 Pt 2 (1961) p 1223

[28] In this first Joint Working Group the American representa... n was provided principally by NASA s Goddard Space Flight Center (GSFC) which was to carry the major burden in this and subsequent cooperative programs A happy blend of professional and human quality of the very highest calibre contributed enormously to the Goddard Center s success in this and later programs Very great credit is due Dr Harry Goett Director of GSFC Dr John W Townsend As i tant Director Space Sciences in whose area the implementation of much of NASA s international programs has fallen and in the case of the fir t British satellite Mr Robert Bauman Project Manager

[29] Ariel was planned originally for launching by means of a NASA Scout vehicle However the particular orbital requirements for the Ariel experiments the final weight of the satellite and developmental uncertainties in the Scout rocket at the time combined to persuade NASA to shift the satellite to the larger Delta vehicle

[30] At this writing plans exist for the British Ariel experimenters to provide a definitive account of their results in *Nature* Interim reports have been given at COSPAR and Goddard Space Flight Center Symposia

[31] An Italian satellite was launched from Wallops Station in an interim step in this program in December 1964

[32] ESRO is treated at greater length in Chapter IV

[33] Sounding rockets are generally smaller rockets intended to carry instruments into a nearly vertical trajectory to a desired altitude in the

earth s atmosphere then drop back to earth They are not intended to place satellites in orbit but rather to make or permit measurements along their flight path sometimes telemetering this information to earth sometimes permitting optical or sound measurements sometimes re turning a package to earth for recovery and examination They are quite as important as satellites since their measurements are normally made at altitudes below those at which satellites can orbit but above the heights at which balloons can fly

[34] Professor Ritchie Calder Earthlings in the Space Age" *The Advancement of Science* (May 1962) p 16

[35] Sir Eric Ashby in a review of Caryl Haskins The Scientific Revo lution & World Politics *Science* (21 August 1964) p 803

[36] The necessary agreements negotiated by the author and Mr Leo nard Jaffe then Director of Communications Satellite Programs NASA were signed in London and Paris in February 1961 They were subse quently made the occasion of a confirming exchange of notes by the respective Foreign Offices and the US Department of State an arrangement requested of the Department by NASA in order to make the Eu ropean commitment upon which NASA was to depend as binding as possible Sir Robert Harvey Deputy Director General of the Briti h Post Office and M Pierre Marzin Director of the Centre National d Etudes Telecommunications were the chief negotiators for the UK and France respectively

[37] This International Meteorological Workshop was held in November 1961 with representatives of some 30 countries attending Those prin cipally respon ible for its implementation were Dr Morris Tepper and Dr William Stroud of NASA and Mr David Johnson of the US Weather Bureau

[38] The fellowship program is conducted on behalf of NASA by the National Academy of Sciences under a grant for the purpose Some twenty US univer ities are participating offering theoretical and experi mental work in laboratories who e directors are normally involved in NASA programs

[39] As in the case of the above program the Resident Research Associateship program is administered by the National Academy of Sci ences under grant from NASA A prime mover in initiating and conducting the program was Dr Robert Jastrow Director Theoretical Institute Goddard Space Flight Center NASA

[40] P H A (Dr Philip H Abelson) International Competition in Science an editorial in *Science* (May 17 1963)

[41] This comparison is based upon an analy is of national reports pre sented to COSPAR (the International Committee for Space Re earch) at its June 1963 reunion in Warsaw and publi hed in the COSPAR Information Bulletin Number 16 December 1963 The Soviet Union report to COSPAR at its May 1964 reunion in Florence included ma

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terial on the bilateral cooperation which had by then materialized with the United States as well as other material

[42] These costs include the capital costs of foreign ground stations for communications satellite tests the purchase of sounding rockets instrumented payloads ground test facilities the direct development of satellites as well as the purchase here of satellite telemetry and power systems solar cells design studies training and travel of personnel, but it does not include expenditures for other basic facilities abroad even though stimulated or required by obligations undertaken for cooperative programs

[43] NASA sites in Nigeria and Mexico are examples As noted in a previous section the station in Mexico is understood to be the first such accommodation of the US by that nation since before World War I

COOPERATION with the SOVIET UNION

ANTECEDENTS

The prospects for cooperation with the Soviet Union in space re search in the course of the International Geophysical Year were substantially frustrated from the beginning Hardly had the two governments announced their intention to launch the first satellites as contributions to the IGY when their scientific representatives be came hopeles ly snarled in efforts to provide for the very simplest exchange of the information and data expected from the two programs As we have seen only a token exchange arrangement may be said to have been worked out in the otherwise very succes ful IGY Yet for a long time—from the formative years of the IGY in 1954–55 until 1962—this limited nongovernmental mechani m of the in ternational scientific community remained the only formal channel for exchanges between the two space powers

Midway in the period consideration was given to placing the IGY on a permanent footing at lea t in three of the mo t sub tantial pro grams engendered by this great international scientific effort the Antarctic oceanographic and space research programs In the ca e of space the International Council of Scientific Unions (ICSU) asked Dr Homer E Newell of the United States to convene a meeting in London in November 1958 to organize an International Committee for Space Re earch as a special committee of ICSU In attendance were delegates of scientific societies in the United States the Soviet Union the United Kingdom, France and other countries which had participated in IGY space projects together with delegates of the major international scientific unions.[1] A conventional charter typi

cal of the arrangements for establishing such groups was drafted and unanimously adopted H C Van de Hulst a young but long famous radio astronomer from the Netherlands representing the International Astronomical Union was elected President Before the delegates scattered to their own countries they were entertained at lunch by the Royal Society The Society's President in a salute to the committee dryly noted that its abbreviated name COSPAR sounded like the title of a Polish opera As subsequent events suggest the remark was more apt than at first appeared

Reassembling in The Hague in March 1959 with somewhat amplified representation [2] COSPAR was abruptly involved in charges that its membership totaling 17 national and professional society delegates was loaded 16 to 1 in favor of the West The charges came from the Soviet Academy's delegate who demanded that the COSPAR charter be revised to provide for more balanced representation of other geographic areas

The issue placed squarely before the meeting was whether the charter of a scientific society should be drawn on political grounds Various delegates taxed the Soviet representative with the responsibility for introducing political considerations into a scientific forum He responded that his interest was not political but rather the even handed representation of science throughout the world Western delegates rejoined that the invitations to participation in the organization and activities of COSPAR had followed demonstrated interest in space research activities that is the launching of satellites or sounding rockets or the tracking of satellites The preponderantly Western representation from the professional societies they argued was

ment made by the minority of one and by his own example, raised COSPAR well above mere expediency

The compromise subsequently worked out was unique in organized science and while it has worked it has continued to be unpopular in the West Essentially it provided that there should be two Vice Presidents of COSPAR one each from the United States and Soviet Academies Moreover, a specified number of additional members of the Committee s executive council were to be elected from slates offered by the US and USSR representatives Thus a political bipolarity was introduced into COSPAR and theoretically veto power in certain actions might be exercised by the Soviet side In fairness it must be stated that the normal basis for achieving a consensus in forums of this type is unanimity Thus there was little practical effect as a precedent was established for political organization of scientific and other international bodies Indeed as expected the Soviet Union sought to represent the COSPAR formula as a precedent for a 'Troika'[3] which it was seeking at that time to introduce also into the United Nations and other areas The President of COSPAR however was not from a neutral nation and so the precedent did not accord with the Soviet objective of tripartite direction of international forums by a neutral chairman with deputies from East and West

The political difficulties which arose at COSPAR s first meeting left little time for business The Western hope was that subsequent meetings might be employed to enlarge the slim area of cooperation in space research laid out during the IGY The Soviet approach appeared to be one of serving the forms of cooperation without substantive commitment Even as late as the third meeting of COSPAR (in Nice in January 1960) progress was confined to very small particulars For example the Soviet Academy delegate stated for the first time that the Soviet Union would announce specified orbital elements of its satellites after launching and give advance notice where the particular characteristics of a planned launching were distinguishable in scientific interest from other launchings Such data was required for simple ground based experiments by scientists of other

ing the launching of the first highly visible American satellite the Echo I balloon satellite Shortly after the launching the International Astronautical Federation convened its annual meeting in Stockholm At a social function attended by hundreds it was reported that Echo I was visible from a small garden Dozens of the celebrants surged into the garden to observe the satellite passing high overhead Standing next to Academician Blagonravov the author reminded him of the possibility of conducting voice communications over long distances by reflection from Echo I The technique had already been successfully demonstrated at the conference then in session by means of a tape recording of a message from President Eisenhower The author suggested that the two countries communicate with each other by means of the satellite in a gesture of friendliness and a step toward cooperation Blagonravov readily agreed In discussing this prospect further it became evident that the satellite was not high enough to provide mutual visibility for communications purposes directly between the US east coast and the Soviet Union Dr William F Pickering Director of the Jet Propulsion Laboratory, also present, suggested that the US utilize the Jodrell Bank radio telescope in England as its terminal This was readily agreed and it was left to the Americans to make the arrangements with Jodrell Bank s director, Dr Bernard Lovell and to provide the necessary information of *frequencies and orbits to Blagonravov This was promptly done* following the Stockholm meeting An answering cable was then received from Blagonravov indicating that unspecified difficulties had arisen and that it would not be profitable to pursue the matter in view of Echo I s brief orbital expectancy The matter appeared ended with the US response noting that Echo I was now believed to have quite a long future and so would be available if the difficulties should disappear

This brief catalog does not begin to represent a full account of US efforts to bring the Soviet Union to cooperation Numerous private and semi official approaches were also made in IAF committees in the annual Pugwash meetings and through Academy and university channels Any of these might have been given little weight by

THE DRYDEN BLAGONRAVOV AGREEMENTS

The first change in the Soviet position came in the course of correspondence between President Kennedy and Chairman Khrushchev in February and March 1962 As in the case of previous manned flights on both sides Khrushchev sent his congratulations to President Kennedy on the occasion of the first orbital flight by an American John Glenn In his congratulatory telegram, Khrushchev remarked

> If our countries pooled their efforts—scientific technical and material—to explore outer space this would be very beneficial to the advance of science and would be acclaimed by all peoples who would like to see scientific achievements benefit man and not be used for cold war purposes and the arms race [9]

While unexceptionable these sentiments were not unusual Such remarks had accompanied the public statements of both sides before What was different was the character of President Kennedy s prompt response In this he stated

> I am instructing the appropriate officers of this Government to prepare new and concrete proposals for immediate projects of common action and I hope that at a very early date our representatives may meet to discuss our ideas and yours in a spirit of practical cooperation [10]

This move to translate sentiment and generalization into concrete action was President Kennedy s first and very great contribution to the cause of international cooperation in space The job of supplying specific proposals to be advanced to the Soviet Union fell naturally to the National Aeronautics and Space Administration (On this matter NASA worked principally with the Department of State although all interested agencies reviewed the material to be sent to the Soviet Union) To this task President Kennedy brought a second contribution of critical importance He made it quite clear that the objective was in fact to be cooperation rather than the scoring of propaganda gains (In fact his correspondence with Khrushchev was so handled that letters reached the *Soviet Union before* they were made public in the US a more significant tactic than may appear)

lunar surface or definition of a detailed investigation of Mars or Venus step by step including manned flight.

Chairman Khrushchev replied in kind again within two weeks[12] He provided his own shopping list of proposals, noting that "some of them are also mentioned in your message" If the two letters are to be contrasted however Khrushchev s is longer le s specific and contains what is to western eyes a curious mixture of technical legal, and political matters Mr K put first the question of coopera tion in long distance communications by satellite second coopera tion in world wide weather prediction by means of satellites and third, a joint program for radio and optical observation of lunar and planetary probes Then came a proposal for an international agreement for the rescue and recovery of fallen spacecraft Returning to the technical he concurred in the plan to map the earth s magnetic field by satellite and in the exchange of space medicine data Finally referring to action then going forward in the United Nations he suggested that space experiments which could complicate other na tions space efforts should be the subject of preliminary international agreement 'Thus Mr Pre ident do we conceive of—shall we say—heavenly matters Khrushchev concluded with expression of a sincere desire to conquer space hand in hand' but then observed that rockets for military purposes and spacecraft launched for peaceful purposes are based on common scientific and technical achieve ments a fact which must limit peaceful space cooperation 'until an agreement on general and complete disarmament is achieved Joint construction of lunar and planetary space vehicles for example could come only after that time Here disarmament was posed as a condition only for advanced cooperation no longer as a prerequisite for any cooperation at all Mr Khrushchev confirmed that his rep resentatives would be available at the United Nations meeting later that March to discuss the possibility of joint projects

The President appointed Dr Hugh L Dryden Deputy Adminis trator of NASA as his representative and Dr Dryden with col leagues met with Academician A A Blagonravov on the appointed occasion in New York These meetings were essentially exploratory

and preliminary in character, but the American side did present four brief papers expanding upon its four initial proposals The Soviet group promised to study the papers and to respond with papers of their own at a subsequent meeting—which was in fact held in Geneva toward the end of May, on the occasion of the first meeting of the Technical Subcommittee of the UN Committee on the Peaceful Uses of Outer Sace (There was no connection between the US/USSR bi lateral negotiations and these UN space meetings the principal nego tiators simply took advantage of their presence at the latter to pursue the former However their private efforts were known to the UN body which in each case took official notice of them and expressed satisfaction and hope for a possible rapprochement between the two great space powers)

The Soviet negotiators suggested that agreement be sought to out law surveillance by satellite and to provide for international consid eration of space experiments which might interfere with other space research Dr Dryden made it quite clear that his authority was limited to technical matters and more specifically the negotiation of joint projects of space activity and that he could not discuss legal or political matters Academician Blagonravov accepted this position philosophically not raising such issues again

At the Geneva meetings the one initiative taken by the Soviet side was a paper proposing joint exploration of questions associated with the commercial future of communications satellites—a matter con sidered by the Americans as reserved for attention by commercial interests and the International Telecommunications Union Since the Soviet side had backed away both from the US proposal for an exchange of tracking stations and Khrushchev s own proposal for cooperation in deep space tracking the three remaining primary sug gestions of the US became the focus of these negotiations weather data exchange and satellite coordination mapping of the magnetic field and testing of communications satellites (Academician Blagon ravov had opened the New York discussions in a generous and courtly display by stating that he first wished to discharge his two year old "promise to the author by arranging for mutual tests by means of

the Echo satellite Echo I by then having deteriorated considerably the US side shifted this prospect to Echo II scheduled to be launched at a later time)

All in all the negotiations were congenial direct and almost immediately fruitful a tribute to the good sense and judgment of both Dr Dryden and Academician Blagonravov and to the initiative of the United States side An interesting contretemps developed at the last moment, however when the first agreement was receiving its final review Provision had been made (by the American side) for signature by the two principals But a Soviet advisor objected to any signatures The Americans protested vigorously that the entire negotiation would be meaningless unless evidence of agreement were forthcoming Moreover the document specifically provided for its review by the two governments before it could go into effect Academician Blagonravov finally worked out a simple solution and signed a covering note which incorporated the attached agreement by reference

This first agreement embraced three joint projects following the US proposals on meteorology and geomagnetism very closely and reflecting Blagonravov s interest in the Echo experiment in satellite communications Briefly it provided for a two phase approach to cooperation in satellite meteorology In the first and experimental phase (1963-64) a joint working group would set up a conventional full time communications link between Washington and Moscow for the two way exchange of selected weather data obtained by satellite the cost to be shared and the link initiated when the US and the USSR were able to exchange data of approximately equivalent interest In the second and operational phase (1964-65) the two countries would each launch weather satellites on a coordinated basis exchanging the data in 'real time (virtually as received) and disseminating it further with consideration to recommendations by the World Meteorological Organization A joint working group was to commence planning for this second phase early in 1963 In public reports this second phase has often been slighted or omitted entirely despite the fact that it represents by far the most important and promising element of the entire agreement for it does no less than provide

for the US and USSR to share the central responsibility and cost of providing an operational weather satellite system, on a global basis and for the benefit of all men

The econd project under the Dryden Blagonravov agreement called for each country to launch a satellite equipped with magnetom eters during the period of the International Years of the Quiet Sun (beginning in 1965), coordinating their orbits and in addition facili tating the exchange of magnetic field data obtained by ground instruments Here too a joint working group was to move imple mentation of this project along

On the third project it was very simply agreed that the two sides would cooperate during 1962–63 in experiments utilizing the next US *ECHO* satellite Further they would consider experiments with active communications satellites (*ECHO* is a passive reflector con taining no communications instrumentation) and discuss at some future time possibilities for *experimental* space communications sys tems involving other countries [13]

The agreement provided for a two month grace period during which changes might be made by either side Neither proposed such changes Then in accordance with the provision for referral to the respective governments and after an exchange of notes between the American Embassy in Moscow and the Soviet Ministry of Foreign Affairs indicating approval by both governments President Keldysh of the Soviet Academy and Mr James E Webb Administrator of NASA exchanged letters which established the agreement at an agency to agency level [14]

To accelerate the establishment of the agreed joint working groups Dr Dryden and Academician Blagonravov met again in Rome in March, 1963 and in Geneva in May of the same year accompanied by various advisors and experts A highly detailed and extensive im plementing agreement was reached termed a ' First Memorandum of Understanding to Implement the Bilateral Space Agreement of June 1962 [15] An excellent portrait of the character of the Rome negotia tions is available in the transcript of a press conference held by Dr Dryden on his return to NASA [16] From this it is clear that the details

of the weather satellite data and launching program were filled in with relative ease that some limitations were encountered in the communications satellite project and that more significant difficulties were met on the magnetometer satellite experiments In the last case, no agreement was reached in Rome and it was necessary to pick up the threads again in a subsequent meeting in Geneva (May 1963) Since *ECHO* II s altitude did not afford mutual visibility between radio terminals in the eastern US and the Soviet Union, it was necessary to enlist the assistance of Sir Bernard Lovell to provide for tests between his Jodrell Bank radio telescope and the Soviet terminal at Gorky State University

An example of the care taken to ensure a meeting of minds in the execution of these cooperative projects may be seen in the provisions governing characteristics of the weather data to be exchanged On the single issue of the brightness levels of cloud cover photographs it was provided that these should have six to ten levels of gray at the satellite receiving stations five to six levels at the end of the communications link used for their exchange and that some original photographs should be mailed to the receiving country for interpretation purposes

As might be expected the first detailed negotiations produced some differences in readine s to proceed along certain lines In his subsequent press conference[16] Dr Dryden noted that the *ECHO* II experiment was to be implemented using radio transmissions at 162 megacycles We ourselves he said are not so much interested in 162 megacycles because our chief interest in ECHO II is in the rigidity and smoothne s of the balloon We really would like to use much higher frequencies frequencies of the order of those we are using with the active communications atellites to get a finer resolution of detail [of the character and condition of the balloon surface] We did get agreement that within the next few months the Soviets would con ider the u e of higher frequencies It depends on the availability of equipment of cour e and the po sibilities of modifying existing antennas"

On the matter of magnetic field satellites Dr Dryden commented

Here we ran into some difficulty and ran out of time so that we will resume the discussions in Geneva I think the matters at issue are not of great importance to you at this time In general, we seek always to get close to the original data the original observations themselves and there is a little tendency [on the part of the Soviet scientists] to want to exchange data that has various corrections made to it' The language of the final agreement reached subsequently at Geneva on this point suggests that the issue of corrections was not fully resolved it stated With a view towards the desirability of working out a common method of introducing time variation corrections into the results of observations from satellites, it is agreed that each side conduct research in this direction and exchange results with the other side"[17]

Dr Dryden also provided the press with an engaging insight into the human aspects of the negotiations

> All three of our meetings have [followed] a kind of protocol that we should meet first in the territory of one and then in the territory of the other In this case the first meeting was a ceremonial of sorts a greeting of the two delegations by the counselor of the US Embassy in the absence of the Ambassador The second meeting it was necessary that we go to the USSR Embassy and be greeted by the Soviet Ambassador Following then we alternated between Via Abruzzi [the new offices of the US Veterans Administration in Rome] and the summer home of the Soviet Ambassador which is outside the walls of Rome a very magnificent villa with Gobelin tapestries and sculpture
>
> Generally the pattern was to meet in the morning for about three hours meeting separately in the afternoon After you got established you came in with a draft from the day before on both sides and compared points and argued matters of substance and wording There was very little in the way of fraternizing socially so to speak There were two social occasions a cocktail party given by [Dr Walter] Ramberg the Science Attache of the US Embassy at his residence and a cocktail party given by the Soviets in [their] Embassy
>
> There was no atmosphere of cold war anywhere, and has not been in these meetings since the first one in New York when [Academician] Blagonravov read the Soviet protest against the nuclear tests in the atmosphere Since that time after we

made it clear we had no instructions in that area had no com petence in that area and would not engage in this type of discussion there has never been a mention of any of these questions

The general atmosphere has been a friendly one There is an evident desire to cooperate within the political framework of both countries It has been realized on both sides that the only hope is to stay in areas that are not at the apex of the cold war

There was a little friendly barter and gifts made I noticed some of our people exchanging TIROS [US weather satellite] cuff links or tie clasps or other little articles for similar VOSTOK [Soviet spacecraft] items

Just one more aspect that interested some people These are the difficulties with language There was quite a battery of translators present on both sides but we have found repeatedly that the mere translation of a word from one language to a word in another language is not sufficient to convey the meaning that there are all sorts of connotations that have to be taken into account For example we said the ECHO satellite was to be used for a program to demonstrate communications between the US and the USSR They could not accept this It took us a very long time to find out what the trouble was It turned out the trouble was with the word demonstrate A demonstration on the continent is a group of miners marching on Paris or it is a political demonstration of some sort The whole difficulty disappeared by simply phrasing it that we would make an experiment to test the feasibility of direct communications It doesn t pay to be suspicious too early You have to explore by asking the same questions many *different ways in order to discover what the meaning is* It is a tedious job in many ways not as direct and straightforward as you might think

Together the Bilateral Space Agreement of 1962 and the First Memorandum of Understanding of 1963 constituted a total agreement for the first three projects (plus an arrangement attached to the 1963 memorandum for discussions on the scientific aspects of the Mars and Venus probes which had already been launched by the USSR and the US respectively)

Since they have been grossly misrepresented on occasion [18] it may be u eful to state the essential character of the agreements quite clearly They provide for *coordination* rather than *integration* of effort in other words for a kind of arm s length cooperation in which

each side carries out independently its portion of an arrangement without entering into the other s planning design production opera tions or analysis No classified or sensitive data is to be exchanged No equipment is to be provided by either side to the other No funds are to be provided by either side to the other NASA is not required to embark upon any new programs or to modify existing programs The flow of data from each side to the other is conditioned upon mutuality and can easily be terminated if mutuality is not present

What then are the values to be derived from this cooperative pro gram? To operate an adequate weather satellite program for fore casting and research purposes meteorologists consider that coverage of the globe is required at least on a six hour basis A single satellite launched by the United States could not provide such coverage Two satellites can If the Soviet Union provides the second satellite the cost to either side of an adequate system is reduced No other impact upon the planning of either is involved In the case of the commu nications tests via ECHO II it happens that the inflation phase of the balloon was to occur in good part over the Soviet Union as a conse quence of the trajectory of the booster The manner of deployment of the balloon (its separation and inflation process) was of consider able interest to the NASA designers Therefore, the willingness of the Soviet side to consider providing radar and optical observation of this phase was of potential value The communications tests via ECHO II were not in themselves of comparable interest ince it was possible to conduct them at more suitable frequencies within the US However a useful exercise in working together in the definition of the tests and in their execution was at hand Finally the mapping of the earth s magnetic field in space is a demanding task in which there are many variables of time space and condition Two satellites can be many times more valuable than one in such a situation Given the central importance of the magnetic field to many near earth space problems this joint project offers promise and value in proportion to the detail of the data to be provided

Always the proof of the pudding is in the eating The critical ele ment in an agreement with the Soviet Union or any other country is

of course in its implementation How has the first effort turned out? As of this writing it is possible to say the following The first test of the Dryden Blagonravov agreements came in Warsaw in June 1963, in the discussion of the Soviet Mars and U S Venus probes.[17] While a congenial and interesting discussion was had it cannot be said that it was fully satisfactory from the U S point of view (and may not have been entirely satisfactory from the Soviet viewpoint either though for different reasons) The fundamental shortcoming from the U S point of view is easily explained Its significance for the total question of cooperation in space matters with the Soviet Union on the other hand is hard to overstate for it is central to all exchanges and relationships It may be illustrated by the discussion of the Soviet micrometeoroid experiment carried in the Mars probe Soviet scientists had reported publicly and repeated privately in somewhat greater detail their very interesting findings micrometeoroid counters aboard their Mars probe had apparently passed through the well known Taureid belt of these particles verifying its character then recorded no hits until passing through a similar but hitherto unknown shower of particles at a far greater distance from earth. The numbers of hits were given together with the distances involved To understand the data US scientists asked what was the minimum size and energy of particles which could be registered by the Soviet counters whether they had been on at all times or only at particular times whether micrometeoroid impacts were recorded for a total history or were noted only periodically during samplings of the probe s experience and so on Those questions which appeared to involve instrumentation design and performance were not generally an wered in meaningful terms The session actually ended up with more uncertainty than at the start

There is little ground to question the sincerity of the Soviet scientists involved their pride in their work or their desire to be fully informative about it The facts suggest however either less familiarity in some cases with the operational and hardware aspects of their experiments than is the case in the United States or a relatively greater reluctance on the part of their government authorities to re

veal even peripherally the state of the art, or both In any case, the result is to handicap possibilities for cooperation most seriously at the outset. When it is remembered that in this micrometeoroid example we are talking only of the instrumentation required immediately for pure science not of basic rocket and spacecraft technology, the extent of the handicap becomes even clearer A wider appreciation of this example would make for greater realism in questions of cooperation in space matters with the USSR Indeed, an awareness of this problem accounted for the particular choice of proposals put forward to Mr Khrushchev by President Kennedy in the first place and for the relatively successful results of the subsequent negotiations

The second test of the Dryden Blagonravov agreement involved the Echo II observations and tests in the period following the launching of that satellite by NASA in early 1964 In the correspondence required for advance arrangements certain differences in concern for deadlines in responsiveness, and in adherence to agreed procedure emerged rather clearly However it would be premature to assess their importance or indeed to ascribe to them any particular motivation Still they must be reckoned in the scales With regard to substantive matters the Soviet participation like water tended to seek lower levels For example while the Soviet side had not wished to commit itself to optical or radar observations of Echo II s inflation phase nor to tests at higher frequencies it had been hoped that the USSR would find it possible to do a fair amount of this work In fact only the optical observations were made and the other activities were not found possible. Of somewhat more concern was the discovery that the Soviet side had been planning only to receive signals via Echo II not to send them This disappointment of consequence only for the symmetry of the project rather than of technical moment possibly reflected technical obstacles but probably also a constant difficulty over the meaning of words like exchange' Whereas the NASA representatives understood the word to have a two-way connotation the Soviet side did not (And one is forced to consider that the meaning of the word may in fact have been downgraded.) In any

event the Soviets at the eleventh hour said that the observatory chosen for the tests did not have a transmission capability at frequencies compatible with those at the Jodrell Bank terminal to be used by the West

On the positive side Soviet optical facilities did photograph the Echo II satellite in its early passes and passed the e observations on to NASA The Soviet radio observatory at Gorky then did receive various test transmissions from Jodrell Bank over a period of days and reported back promptly on their technical aspects A fuller technical report was provided after a brief period including extensive details of radio oscillation effects and tape recordings of the receptions (Academician Blagonravov later suggested the possibility of a second phase for these experiments proposals were made to him by Dr Dryden for further efforts premised clearly upon two way transmissions The results are not known at this writing)

Beyond these two direct tests implementation of the Dryden Blagonravov agreement had begun to trail well behind the specific schedules laid down Yet some balance must be preserved in these matters After all the Echo II launch by NASA came some months after it had been scheduled for use in the joint program It is normal that space projects suffer some slippage and the likelihood is that some similar experience delayed initiation of the weather data and satellite project on the Soviet side

Indeed this seemed to have been the case when the Soviet side agreed in a further meeting in Geneva in May 1964 to proceed at last with the weather data communications link agreed on in 1962 Accordingly steps are underway at this writing to establish the link and begin the exchange of conventional weather data[10] in anticipation of the promised availability of (Soviet) satellite data early in 1965

It is of some significance also that Soviet initiative produced a new proposal at the May 1964 meeting This propo al called for the joint preparation of a major review in the form of a joint publication of pa t US and Soviet work in space biology and medicine with some attention to future problems in the fields While of uncertain intrinsic value this depending much on the character of the contri

butions to the review such a project could serve to expand the co operative relationship into the field of manned flight

Perhaps the salient conclusion at this point must be that agree ments have in fact been reached that significant efforts have followed to implement them but that restraint and constraint still figure sig nificantly on the Soviet side Nevertheless, one observer was prompted to say that the negotiations followed a path 'that by comparison with other attempts at Soviet American cooperation has been lined with roses all the way '[21]

THE LOVELL CORRESPONDENCE

By all odds the strangest chapter in US/USSR space relationships and in the events leading to President Kennedy s UN proposal for a joint lunar effort was that which opened with a letter addressed to Dr Hugh L Dryden Deputy Administrator of NASA by Sir Bernard Lovell Professor at the University of Manchester and Director of the Jodrell Bank radio telescope activity

Lovell s letter was written in July 1963 immediately after a trip he had taken to the Soviet Union and was later published in the Congressional Record He reported that he had been taken to see a Soviet tracking station which has not so far been seen by Western eyes or by many Soviet scienti ts He described cooperative pro grams which he had negotiated with Soviet agencies and the presi dent of the Academy of Sciences of the USSR He reported on three major elements in Soviet space programming including a rejection of plans for a manned lunar landing and promised the President of the Academy to convey his (the president s) views to appropri ate authorities in the United Kingdom and United States that he believed the appropriate procedure would be to formulate the [manned lunar] task on an international basis

The press widely interpreted Sir Bernard s letter as a feeler from the Soviet Union for cooperation in manned lunar projects In this country the letter was read into the Congressional Record with the following comment

> We have now reached a point which may be a break in what hitherto has been the intransigent opposition of the Soviet Union to any adequate cooperation in outer space No doubt many Senators read this morning in the Washington Post an article under the byline of Howard Simons entitled United States Russia May Join in Moon Effort The article states that the United States is interested in following up the Soviet suggestion that can lead to a joint United States Soviet effort to send men to the moon

A more careful analysis of Lovell's letter raised many questions —Lovell concluded from the fact that he personally had been permitted to visit *a* station in the Soviet Union that it does seem to underline the apparently genuine desire of the Academy to extend its cooperation with the West' This conclusion is difficult to understand unless one takes Sir Bernard to represent the West' in which case confusion again descends as one tries to understand why the Academy would not have invited other visitors more centrally involved in the space programs of the West in order to express 'its genuine desire to extend its cooperation'

—The next six paragraphs of Sir Bernard s letter were devoted to 'cooperative programs he negotiated with Soviet agencies all except the last relating to radio and optical astronomy rather than space flight programs The last concerned an extension of our cooperative work with the Soviet Union in the tracking of their lunar and deep space probes While describing this as a cooperative program already negotiated Lovell nevertheless said of it,

> my impression is (i) that a real effort will be made to provide us with earlier and more complete information about the details of the probe (ii) that quite serious consideration is now being given to our offer to accommodate a small number of Soviet scientists at Jodrell Bank in connection with these programs (a precedent was set in June 1961 when two Soviet Scientists came to Jodrell Bank to search for the signals from the Venus probe)

It was not clear in what sense the provision of tracking services constituted mutual cooperation particularly since the Soviet side had never provided information necessary to decipher their telemetry signals

—The remainder of the letter was devoted to space projects proper,

listing three major directions of the Soviet space program It was Lovell s impression that the Soviets had determined to perfect the rendezvous technique with an immediate aim (perhaps 1965–66) of e tablishing a manned space platform for astronomical observations at a height of 150–200 miles ' In view of Soviet reluctance to discuss such plans with others time alone can validate this report It is worth passing mention, however that an astronomical platform is often thought of as an *unmanned* project because the high pointing pre cision required may easily be compromised in the weightlessness of space by the movements of a crew unless remote coupling is pro vided

—Lovell s second observation on Soviet space plans was I think it can be assumed that apparatus is now in process of assembly for the attempt to make a soft landing of instruments on the lunar sur face and that the launching will be made in a matter of months Over one year has elapsed since this observation was transmitted but it is undoubtedly true that Soviet space schedules slip even as do those of the United States and Lovell s assumption in this case may be entirely reasonable

—Without question the mo t intricate of Lovell s reports was the final one relating to manned lunar programs Lovell said that Presi dent Keldysh of the Soviet Academy informed him that plans for the manned lunar landing had been rejected for three reasons the ex posure of cosmonauts to solar radiation the absence of an economic solution to the problem of assuring a return to earth and the belief that instrumental probes could solve the scientific problems more quickly than manned probes The Academy might revive the project "if progre s in the next few years gave hope of a solution to their problems But in his next sentences Lovell said that

> the Academy believed that the time was now appropriate for sci enti ts to formulate on an international ba is (a) the reasons why it is desirable to engage in the manned lunar enterprise and (b) to draw up a list of cientific tasks which a man on the moon could deal with which could not be olved by in trument alone The Academy regarded this initial tep a the fir t and mo t vital in any plan for procee ling on an international ba is

If read in context, the above sentences clearly do not suggest international cooperation in manned flight to the moon. Instead they suggest international consideration of the reasons for manned missions to the moon, and especially why the purposes of manned missions could not be accomplished better and more cheaply by instrumental probes. Remembering that Lovell said the Academy had already reached its conclusions on these questions, namely that manned lunar flight was not now feasible and that instrumental probes were to be preferred, it would then follow from Lovell's letter that the Academy was seeking international support for its negative conclusions — not cooperation in moon projects.

To proceed a step farther, the attitude of scientists abroad toward manned lunar flight has been generally cool or even hostile and is widely known to be so. They have been remote from the two programs—although the US program is open to their interest—and have had little concern for the larger technological, as contrasted with scientific, values of manned missions. Thus the conclusions of an international scientific body convened to consider the matters listed by Lovell would very possibly be negative; in other words they could be expected to support the conclusions already said by Lovell to have been reached by the Soviet Academy with regard to its program. Yet, as we have seen, the press and some public officials joined in interpreting the letter as a feeler for cooperative activity.

The reported Soviet decision to suspend manned lunar efforts for some years, if not permanently, was given wide credence. It contributed to serious debate of the need for a competitive US program: were we not competing only with ourselves, some asked? And it may well have contributed to the serious budgetary reverses for the NASA program which followed.

No one took the time to note that the press had been riding two horses simultaneously, although the beasts were headed in opposite directions. For the press suggested both that the Soviets had dropped their moon program and that they wished to cooperate in pursuing it.

The implications of NASA's own response to Lovell were apparently not understood. A letter addressed to Sir Bernard by James

E Webb Administrator of NASA thanked him for his thoughts drew a careful distinction between Lovell s own cooperative arrange ments and space programs firmly noted that an official channel for positive agreement on space cooperation had already been established between Dr Dryden and Academician Blagonravov and concluded with the simple remark that if the Soviet Academy is indeed in terested in the matters you describe in your letter we will look for ward to the possibility of further explorations by these two gentlemen[23] NASA s response to press inquiry might also have helped but apparently did not i sued on August 9 it tated

> Sir Bernard Lovell s letter to Dr Dryden represents the personal impressions of a private individual on a matter of the greatest obscurity—the Soviet space program Accordingly it would not seem wise at this time to give the letter undue importance al though naturally we are glad to have it
>
> Contrary to some reports Sir Bernard s letter does *not* convey any proposal by the Soviet Academy for the US and the USSR to cooperate in their lunar program It raises only the possibility of a discussion of some of the reasons for manned lunar explora tion—the scientific reasons As Mr Webb s reply indicates we already have a channel of communications and have even achieved an initial agreement with the Soviet Academy of Sciences on space matters It seems reasonable to expect that that channel will be used for any serious and ubstantive propo als regarding co-operation in major national programs in the space field

In the next several months Soviet statements by astronauts and others multiplied in contradiction to Lovell s report all asserting the continuing intention of their country to pursue manned lunar pro grams A statement by Khrushchev that no deadline was nece sarily imposed on the Soviet effort was again misinterpreted widely by the press as representing an abandonment of the project Finally exas perated by the que tions of a touring group of American bu inessmen as to why he had dropped manned lunar ambitions Khru shchev lashed back saying they not he had stated uch a conclu sion and that nothing could be farther from the truth

The penultimate irony was the following pre s comment when it was all over

KHRUSHCHEV CONFIRMS USSR LUNAR PROGRAM

Soviet Premier Nikita Khrushchev has made it emphatically clear that the USSR has neither deferred" po tponed or 'withdrawn" its competitive lunar landing program Rather he says his country will launch a man to the Moon when all preparations have been completed that will ensure his safety

In making the announcement he chided United States specula tion that the Soviet Union has changed its lunar landing plans for economic reasons In regard to the question of whether we have given up the lunar project for economic reasons or other wise he said 'we have never said we are giving up our lunar project You re the ones who said that'

Khrushchev s remarks hopefully coming at a time when the memories are still fresh will be a warning to members of the general press and many members of our national leadership that inaccurate translation quotation and interpretation or analysis of the antagonists proclamations on the still very technical and com plex arena of space can afford a very embarrassing psychological victory to those antagonists If members of the general press had resorted to the expediency of consulting with our own national space leadership for instance Dr Edward Welch of the National Space Council (a technical advisor more than a political appoint ment) it would not have appeared that our entire national space program was a tail wagged by Premier Khrushchev

This past year has seen an excess of spur-of the moment inter pretations reflected in assaults upon the whole concept of the national space program and the age-old philosophy of national competition to a point where there has been a weakening of our nation s determination at a time when the antagonist is demon strating a continuing space technology leadership At the risk of being repetitive it should be recorded that many in our Congress and much of our general press have a history of placing our space leaders on trial by the proclamations from an audience either completely ignorant of the technology of space and its implica tions or from foreign or antagonistic onlookers [4]

The ultimate irony was a statement by President Keldysh of the Soviet Academy repudiating the Lovell letter So far as can be de termined it has never been reported in the US press (although called to press attention) An English language radio report of a pre s conference held by Keldy h in Prague on October 14 1963 refuted the statement made by Bernard Lovell Director of the British Ob

servatory in Jodrell Bank, that according to President of the USSR Academy of Sciences M V Keldysh, the Soviet Union has abandoned at least for the near future its aim to land a man on the moon The report continued ' Academician Keldysh today said Professor Lovell obviously came to his conclusion by himself as we have never said this The tasks of making a safe manned landing on the moon are without doubt very exacting and demand great preliminary research We therefore cannot say precisely when we will realize this task.' '

Whether Sir Bernard understood the Soviet scientists remarks to him correctly, whether such remarks in any case reflected the views of Soviet authorities who in fact direct the manned space programs of the USSR and if so whether minds and policies were then changed (making an innocent victim of Sir Bernard)—these questions are unlikely to be resolved now However the dangers of glibness gullibility and punditry are clear enough.

TOGETHER TO THE MOON

Events and information of events surrounding President Kennedy s September 20 speech at the United Nations in which he proposed to explore with the Soviets the possibility of cooperation in space exploration, including manned lunar flight, were by coincidence and happinstance confused to an unfortunate degree Lovell s suggestion that the Soviets had abandoned their lunar effort for a time had been given wide publicity and neither Keldysh nor Khrushchev had yet made their comments repudiating this notion The idea that the Soviet program had been dropped appeared logical to many observers who had always had difficulty in accepting the reality of the Soviet achievement and who felt that the on rushing US program must discourage Soviet competition by making it too expensive Reports of economic difficulties in the USSR and the lengthening shadow of Chinese communism along the Soviet border tended to buttress this view So many were ready to believe that the US would have a clear field in its manned moon program The spectre of a Soviet "first" seemed to recede To some this meant there was no reason

for the US program at all to others it meant that there was no reason to prejudice the increasing possibility of a *US* first' by suggesting cooperation with the Soviet Union to others still it seemed that cooperation was at last feasible since the race was off "[25]

A few days before President Kennedy s UN remarks, Dr Robert R. Gilruth Director of NASA s Manned Space Flight Center was asked at a luncheon what his views were regarding cooperation with the Soviet Union He said I tremble at the thought of the integration of a Soviet rocket with US spacecraft when I think of the problems we have experienced with American contractors who all speak the same language ' Gilruth s remarks came so close in time with the President s proposal that they soon seemed to constitute a comment upon that proposal and were actually handled that way in some press stories In fact Gilruth knew nothing of the President s intended suggestion Moreover the President in no sense directed his proposals for cooperation to the integration of a Soviet rocket and a US spacecraft Even so Gilruth did not say this could not or should not be done His next sentence had been The proposal would be very interesting and significant—but hard to do in a practical sort of way "[6]—as in fact it would be Gilruth s trembling was an entirely rational reaction but in no sense to be interpreted as opposing the President s subsequent suggestion or as applying to other types of cooperation

(The President was not known for his preference for easy tasks he had espoused objectives before because they were difficult One may assume that the manned lunar program itself will be hard to do and makes sensible men tremble even though they feel confident that it will ultimately be carried out successfully In any case the task of placing a man on the moon and bringing him back must in itself be considerably more difficult than the *technical* task of integrating a Soviet rocket and a US spacecraft)

A further source of confusion was careless reporting of a luncheon meeting between Dr Dryden and Academician Blagonravov during the week before President Kennedy s speech Dr Dryden confirmed that he had inquired of Blagonravov regarding current Soviet attitudes toward an extension of the existing bilateral agreement to

manned lunar programs He noted that Blagonravov replied that this subject might be discussed after instrumented unmanned landings had been accomplished Dryden correctly observed that this was "somewhat more favorable than earlier reactions insisting on total disarmament first This simple and totally noncommittal exchange prompted by Dr Dryden was nevertheless transmuted by the press into further evidence that the Soviets were abandoning the moon project and were amenable to even suggesting cooperation

All these *accounts contributed to an apparently coherent and* progressive picture of Soviet readiness either to abandon their own lunar program or to join in a cooperative effort [7] a dangerously misleading view for the credulous the uninformed and the wishful thinkers in official and unofficial places

Ready acceptance of this totally unfounded picture of Soviet interest in manned lunar cooperation contrasted sharply with nonacceptance of the President s own consistent record of interest in the same cooperation The UN proposal having been made a number of Congressmen wondered if the President was backing off from a national goal [28] Others thought his proposal was in conflict with previous positions emphasizing the importance of the manned lunar program [29] In fact the President had consistently made clear his desire for significant cooperation in space and in all other aspects of science He had said in his inaugural address that he wished to invoke the wonders of science instead of its terrors and that we should explore the stars together his correspondence with Khrushchev clearly contemplated cooperation in manned and unmanned planetary exploration and in lunar projects there had been no suggestion that the Dryden Blagonravov *agreement should be limited* by anything but prudence and those limits self imposed by the Soviet side nor had there ever been a suggestion that the US should seek cooperation only in unimportant projects

After the initial press reaction to the UN proposal Kennedy found it necessary to remind the Congress and the press of the obvious that "This great national effort and this steadily stated readiness to cooperate with others are not in conflict. They are mutually supportive

ing elements of a single policy [30] *NASA s Administrator* James E Webb had already been emphasizing this same point publicly [31] Nor was this view of the national space program put forward only after *the fact of Kennedy s speech Much earlier, Mr* Webb had described the program as like Janus having two faces one looking toward competition and national distinction the other toward international *cooperation* [32]

In fact this basic duality was actually well understood despite the doubts voiced after the President s speech For example his con tinuing *purpose had been clearly stated without objection* in an ex change in the Senate only a month before his speech in the UN Early in August Senator Clark proposed an amendment to action before the Senate Committee on Aeronautical and Space Sciences the purport of his amendment was to authorize NASA to obligate and expend funds for cooperative programs with other countries on a basis of equal matching of funds Senator Clark said this is an expres sion of a congressional intent and willingness to match funds—dollar for dollar—with the Russians *in a joint venture to reach the moon or in any other joint venture into outer space* I believe the adoption of this amendment to the committee amendment would make a very real contribution to *efforts the President has been making ever since his inauguration* to persuade the Russians to go along with the peaceful development of outer space [33] *(Italics added)* The amendment was ultimately withdrawn not on the question of limiting cooperation with the Soviet Union—to which no one objected—but largely because it would *limit* NASA to programs in which cooperat ing nations could match the cost No one took exception to Senator Clark s characterization of the President s long standing objectives nor to his interest in facilitating cooperation in a moon venture

One cannot escape the conclusion that much of the adverse reac tion to the President s UN proposal rested on tactical grounds 'The President s specific proposal was inserted very late in the speech writing process and his decision to go ahead with the offer wasn t widely known even within the Administration [34] (There is no ques tion however that James E Webb NASA s Administrator *was*

consulted by the President, he has stated this publicly) The Washington reaction already noted may therefore have reflected pique rather than doubt as to the President s position Thus the proposal may have suffered domestically by reason of the circumstances of its introduction—omission of the usual preparation of the Congress for significant public actions through the briefing of its interested members (Observers have attributed a portion of the cuts made in NASA s budget at the time to irritation at the manner and apparent meaning of the offer, i e the failure to touch base with the Congress and the implication that the space race aspect was no longer important An element in this impression was the passage of an amendment to the NASA appropriation bill requiring NASA to come into the Congress for approval before spending any funds in a joint venture to the moon with the Soviet Union)

Internationally the proposal can also be regarded as unsuccessful in that there has been no Soviet response formal or informal negative or positive [35] At the same time press coverage suggested that the proposal had a notable and positive effect upon its UN audience [36] although this too in the short run at lea t has little substantive meaning Whether such a proposal has long range value of an intangible kind in contributing to a favorable world impression of US intentions or in conditioning and moderating Soviet attitudes is harder to say

The episode po es the question of how best to initiate major proposals for cooperation between countries whether privately or publicly Presumably the normal course where relationships are good is simply to advance a proposition privately Recourse is taken to public forums for initiating propo als where it seems useful to bring public pre sure to bear in support of the effort In a more sophisticated view the private proposal might be a first recourse even where relationships are not particularly good but if this does not bear fruit it might then be publicized in the hope of exercising greater leverage Clearly both approaches have their time and place Yet it may be doubted whether there is a fine appreciation of the inherent limitations of dramatic public demarches A public proposal to another government to join in a complex and consequential en

terprise is likely to find both political and practical obstacles in the way of acceptance one uch obstacle being the defensive position in which the other government is placed by the public initiative itself (It should be noted that White Hou e sources were cited shortly after President Kennedy s UN speech, to the effect that he had privately broached the subject of cooperation in lunar landings with Chairman Khrushchev in June 1961 [37] sugge_ting a constructive private pre view of the UN proposition)

Speculation as to how and whether the President s proposal could be implemented was of cour e rampant and was fed by various private and anonymous opinions One Washington reporter said "A broad sampling of people in the know indicates a con ensus that there is scant possibility of literal achievement of Mr Kennedy s goal [38] Another said But it is evident that most NASA leaders despite indications of a switch in the Soviet attitude have doubts about involving the US in a cooperative lunar landing effort They worry that Soviet secrecy probably would preclude obtaining the kind of information needed to join hands And they continued even if the information were available the mechanical problems of mesh ing space systems developed by two different nations might be enor mous [39] Apart from a certain license in the use of the words people in the know and NASA leaders these speculations undoubtedly represented a grossly oversimplified view of the President s propo i tion The President had said that there is room for new cooperation for further joint efforts in the regulation and exploration of pace I include *among* the e pos ibilities a joint expedition to the moon *(Italics added)* Admini trator Webb and Deputy Administrator Dryden again and again empha ized that the key word in the pro posal was the word explore The President was propo ing to explore whether the cienti ts and a tronauts of our two countries—indeed of all the world—cannot work together in the conquest of space To jump from the uggestion that the matter be explored to the conclu ion that the Pre ident was explicitly a king to put a US spacecraft upon a Soviet booster for a lunar voyage or vice versa or suggesting that American and Soviet a tronauts be paired off for

joint trips to the moon in US or Soviet capsules such conclusions were unwarranted Yet they served as the straw men for the shafts and arrows directed at the 'fea ibility" of the proposal

At lea t two of the constructive sugge tions made through the press by persons with some knowledge of space operations are worth noting since the pros and cons tend to illustrate well the problems that must confront those responsible for serious advancement of US policy The magazine *Missiles and Rockets* publi hed an editorial[40] sugge ting that a joint lunar landing was unlikely to be implemented because the US program was "too far advanced in design and en gineering to make possible any joint technical effort on development of hardware military security freezes the two nations in a posi tion where cooperation involving hardware is undesirable such a joint project will tend to lessen the competitive drive and national support of the exi ting lunar programs [and] the mutual trust necessary to such a joint program does not exist ' Becau e of these disabling considerations the editorial suggested that sights for a cooperative venture be shifted to a more di tant major project a joint program for establi hment of a scientific base on the Moon following the early exploratory lunar flights The premi e was that the planning and engineering of a joint lunar base could be carried out cooperatively without involving the nations respective space hard ware requiring no mating of equipment and therefore no com promise of security Unfortunately current concepts of lunar bases do contemplate utilization of structures and equipments which are themselves extensions of the space vehicle systems designed for early lunar exploration There is likely therefore to be no neat dividing line between the early exploratory programs and ultimate base opera tions if any Seen as a continuum the programs then present the same difficult though not necessarily disabling considerations (It is interesting that the Antarctic precedent was cited in support of this proposal for cooperative planning and engineering of a lunar base though as we have seen in Chapter I the activities of the Soviet Union and the United States in Antarctic re earch are almost entirely independent of each other and in almost a decade have produced no

more than an exchange of three or four personnel on each side and a few visits Their real nexus is their subscription to the very general scientific goals suggested by an international committee The two countries carry out their own programs in independent fashion leaving each other strictly alone)

A second constructive proposal was advanced by Thomas Turner an engineer through the pages of LIFE magazine[41] As LIFE said Turner had devised an ingenious scheme for making the President s plan work According to this scheme the Soviet Union would use a very large booster to put a powerful spacecraft in earth orbit with a capacity for three men but a crew of two The US would use a smaller booster to put a more modest spacecraft in earth orbit thus having a capacity for two men but a crew of one The two spacecraft would rendezvous and dock (join) then proceed together into an orbit about the moon One Soviet and one American astronaut would then use the smaller US spacecraft for a descent to the moon and return to the parent vehicle Reentering the latter they would abandon the small American lunar vehicle and return to earth in the larger Soviet one All that would be needed it was said would be compatible collar and docking devices common atmospheres in the two spacecraft and common communications "Billions" of dollars and much time would be saved

Without evaluating this truly ingenious proposal in definite terms a number of questions can be put to suggest that the matter is indeed far more complex than may appear at first blush. In the present state of US-Soviet relationships would either side enter into an initial joint enterprise which would make it dependent upon the other for the *capability* of carrying out a given objective? Do continuing United States objectives and requirements in space permit the US to forego the development of large boosters leaving this to the Soviet Union? If we believe it necessary in any case to develop such boosters (on the assumption that major space projects don t end with a lunar landing) what then would be the actual savings under the proposal published in LIFE? Is the proposal possible to implement in so dispersed a fashion—could difficult rendezvous and docking maneuvers

be carried out for the first time in the course of an actual assault upon the moon or would not both nations want to approach the problem through identical ground simulation techniques and equipment and common "drills"? Given the very limited near term maneuverability of spacecraft in space would not extensive information and agreement need to be exchanged on launching schedules requiring unprecedented advance notice by the Soviet side and its exposure to failure in a pre advertised venture? Can the Soviet side commit itself to boosting a US spacecraft from earth orbit to lunar orbit without knowing its weight, or could the US commit a spacecraft to such a boost without knowing the booster s thrust and concurring in the estimate of its capability? At the end of a lengthy list of additional questions which might be asked is it technically or politically sound to enter upon so integrated and portentous a project without prior establishment of mutual confidence levels—technical and political—through earlier and more modest joint enterprises exchanges and disclosures?

CONCLUSION

A conclusion to the difficult subject of US Soviet space cooperation is relatively easily put Efforts on the western side have been consistent and patient They have been both specific and general and have ranged from modest proposals to absolutely unequivocal indications that the US is prepared to go as far as the Soviets will go They have been put privately and publicly by scientists politicians and diplomats The history of rejections by the Soviet is almost exactly as long It is both general and specific, and by omission may be assumed to have come from all of the same levels utilized by the United States to advance its purpose A small beginning but one with a large potential, has been made in virtually unprecedented fashion through the Dryden Blagonravov agreements The first implementation of these agreements has begun in a fashion which might, with caution be described as somewhat promising The task of expanding this small beachhead is heavily burdened by the implications of space for military uses and equipments Finally while the major

US overture President Kennedy s lunar proposal has not been ac cepted it has not been rejected either

The entire process has been complicated by wide swings in public interpretations of Soviet intentions aided and abetted by the pre dilections of at least portions of the press for the sensational, the oversimplified the controversial and the speculative

When all is said and done however Soviet attitudes and per formance and indeed personal relationships with their representa tives all have come a long way since the early days of the Interna tional Geophysical Year The process has been very slow but heartening and performance has warranted a steady growth in per sonal trust In fairness one must assume that a similar view has had to grow within the Soviet Union Possibly crude pressures upon Soviet scientists by individual US colleagues in the first years of the space age have generally given way to a greater understanding of difficulties and restrictions which are sometimes more mutual than *we may realize The prescription for the future can only be patience* and persistence on both sides

NOTES

[1] The national scientific societies represented at the organizational meeting of the International Committee for Space Research were those of Australia Canada France Japan the USSR the United Kingdom and the US these having been invited as participants during the IGY in satellite sounding rocket or formal satellite tracking programs In addi tion there were in attendance representatives of the following inter national scientific unions affiliated with the International Council of Scientific Unions Astronomy Pure and Applied Physics Geode y and Geophysics Radio Science Theoretical and Applied Mechanics Biolog ical Sciences Physiological Sciences and Pure and Applied Chemistry

[2] National societies repre ented at the second COSPAR meeting were tho e which had been present at the first (see above) plus that of South *Africa International Unions represented at the second meeting were* tho e listed above the Mathematics Union

[3] "Troika" was the term applied to tripartite (US USSR neutral) leader hip of a given forum

[4] *IG Bulletin* National Academy of Sciences (Dec 1963) p 12

[5] This visit, arranged by the National Academy of Sciences as host to the conference took place after the launching of the first Soviet sputnik on October 4

[6] Other NASA officials present were Dr Homer E Newell Dr John W Townsend and the author

[7] The meeting was arranged privately at the Hotel Sheraton Park in Washington D C on the occasion of an annual conference of the American Rocket Society

[8] This offer of tracking and data acquisition assi tance was made in a speech by Dr Glennan on Dec 7 1959 before the Institute of World Affairs Pasadena California

[9] Feb 21 1962

[10] Feb 22 1962

[11] Full text of President Kennedy s letter of March 7 1962 to Chairman Khrushchev proposing specific projects for cooperative action follows

> Dear Mr Chairman
>
> On February twenty second last I wrote you that I was instructing appropriate officers of this Government to prepare concrete proposals for immediate projects of common action in the exploration of space I now present such proposals to you
>
> The exploration of space is a broad and varied activity and the possibilities for cooperation are many In suggesting the possible first steps which are set out below I do not intend to limit our mutual consideration of desirable cooperative activities On the contrary I will welcome your concrete suggestions along these or other lines
>
> 1 Perhaps we could render no greater service to mankind through our space programs than by the joint establishment of an early operational weather satellite system Such a system would be designed to provide global weather data for prompt use by any nation To initiate this service I propose that the United States and the Soviet Union each launch a satellite to photograph cloud cover and provide other agreed meteorological services for all nations. The two satellites would be placed in near polar orbits in planes approximately perpendicular to each other thus providing regular coverage of all areas This immensely valuable data would then be disseminated through normal international meteorological channels and would make a significant contribution to the research and service programs now under study by the World Meteorological Organization in response to Resolution 1721 (XVI) adopted by the United Nations General Assembly on December 20 1961
>
> 2 It would be of great interest to those re ponsible for the conduct of our respective space programs if they could obtain operational tracking services from each other s territories Accordingly I propo e that each of our countries establish and operate a rad o tracking station to provide tracking services to the other utilizing equipment which we would each provide to the other Thus the United States would provide the technical equipment for a tra king station to be e tablished in the Soviet Union

and to be operated by Soviet technicians. The United States would in turn establish and operate a radio tracking station utilizing Soviet equipment. *Each country would train the other's technicians in the operation* of its equipment, would utilize the station located on its territory to provide tracking services to the other, and would afford such access as may be necessary to accommodate modifications and maintenance of equipment from time to time.

3. In the field of the earth sciences, the precise character of the earth's magnetic field is central to many scientific problems. I propose therefore *that we cooperate in mapping the earth's magnetic field in space by* utilizing two satellites, one in a near earth orbit and the second in a more distant orbit. The United States would launch one of these satellites while the Soviet Union would launch the other. The data would be exchanged throughout the world scientific community, and opportunities for correlation of supporting data obtained on the ground would be arranged.

4. *In the field of experimental communications by satellite,* the United States has already undertaken arrangements to test and demonstrate the feasibility of intercontinental transmissions. A number of countries are constructing equipment suitable for participation in such testing. I would welcome the Soviet Union's joining in this cooperative effort which will be a step toward meeting the objective contained in United Nations General Assembly Resolution 1721 (XVI), that communications by means of satellites should be *available to the nations* of the world as soon as practicable on a global and non-discriminatory basis. I note also that Secretary Rusk has broached the subject of cooperation in this field with Minister Gromyko and that Mr. Gromyko has expressed some interest. Our technical representatives might now discuss specific possibilities in this field.

5. Given our common interest in manned space flights and in insuring man's ability to survive in space and return safely, I propose that we pool our efforts and exchange our knowledge in the field of space medicine, where future research can be pursued in cooperation with scientists from various countries.

Beyond these specific projects we are prepared now to discuss broader cooperation in the still more challenging projects which must be undertaken in the exploration of outer space. The tasks are so challenging, the costs so great, and the risks to the brave men who engage in space exploration so grave, that we must in all good conscience try every possibility of sharing these tasks and costs and of minimizing these risks. Leaders of the United States space program have developed detailed plans for an orderly sequence of manned and unmanned flights for exploration of space and the planets. Out of discussion of these plans, and of your own, for undertaking the tasks of this decade would undoubtedly emerge possibilities for substantive scientific and technical *cooperation in manned and unmanned space investigations. Some pos*sibilities are not yet precisely identifiable but should become clear as the space programs of our two countries proceed. In the case of others it may be possible to start planning together now. For example, we might cooperate in unmanned exploration of the lunar surface, or we might

commence now the mutual definition of steps to be taken in sequence for an exhaustive scientific investigation of the planets Mars or Venus, including consideration of the possible utility of manned flight in such programs When a proper sequence for experiments has been determined we might share responsibility for the necessary projects All data would be made freely available

I believe it is both appropriate and desirable that we take full cog nizance of the scientific and other contributions which other states the world over might be able to make in such programs As agreements are reached between us on any parts of these or similar programs, I propose that we report them to the United Nations Committee on the Peaceful Uses of Outer Space The Committee offers a variety of additional opportunities for joint cooperative efforts within the framework of its mandate as set forth in General Assembly Resolutions 1472 (XIV) and 1721 (XVI)

I am designating technical representatives who will be prepared to meet and discu s with your representatives our ideas and yours in a spirit of practical cooperation In order to accomplish this at an early date I suggest that the representatives of our countries who will be coming to New York to take part in the United Nations Outer Space Committee meet privately to discuss the proposals set forth in this letter

Sincerely

John F Kennedy

[12] Text of March 20 1962 letter from Chairman Khrushchev in reply to President Kennedy s letter of March 7 1962

Dear Mr President

Having carefully familiarized myself with your message of March 7 of this year I note with satisfaction that my communication to you of February 21 containing the proposal that our two countries unite their efforts for the conquest of space has met with the necessary understanding on the part of the Government of the United States

In advancing this proposal we proceeded from the fact that all peoples and all mankind are interested in achieving the objective of exploration and peaceful u e of outer space and that the enormous scale of this task as well as the enormous difficulties which must be overcome urgently demand broad unification of the scientific technical and material capabilities and resources of nations Now at a time when the space age is just dawning it is already evident how much men will be called upon to accompli h If today the genius of man has created space ships capable of reaching the surface of the moon with great accuracy and of launching the fir t co monauts into orbit around the earth then tomorrow manned spacecraft will be able to race to Mars and Venus and the farther they travel the wider and more immense the pro pects will become for man penetration into the depths of the universe

The greater the number of countries making their contribution to this truly compl cated endeavor which invol es great expense the more

swiftly will the conquest of space in the interests of all humanity proceed And this means that equal opportunities should be available for all countries to participate in international cooperation in this field It is precisely this kind of international cooperation that the Soviet Union unswervingly advocates true to its policy of developing and strengthening friendship between peoples As far back as the beginning of 1958 the Soviet government proposed the conclusion of a broad international agreement on cooperation in the field of the study and peaceful use of outer space and took the initiative in raising this question for examination by the United Nations In 1961 immediately after the first space flight by man had been achieved in the Soviet Union we reaffirmed our readiness to cooperate and unite our efforts with those of other countries and most of all with your country which was then making preparations for similar flights My message to you of February 21 1962 was dictated by these same aspirations and directed toward this same purpose

The Soviet Government considers and has always considered the successes of our country in the field of space exploration as achievements not only of the Soviet people but of all mankind The Soviet Union is taking practical steps to the end that the fruits of the labor of Soviet scientists shall become the property of all countries. We widely publish notification of all launchings of satellites spaceships and space rockets reporting all data pertaining to the orbit of flight weight of space devices launched radio frequencies etc

Soviet scientists have established fruitful professional contacts with their foreign colleagues including scientists of your country in such international organizations as the Committee of Outer Space Research and the International Astronautical Federation

It seems to me Mr President that the necessity is now generally recognized for further practical steps in the noble cause of developing international cooperation in space research for peaceful purposes Your message shows that the direction of your thoughts does not differ in essence from what we conceive to be practical measures in the field of such cooperation What then should be our starting point?

In this connection I should like to name several problems of research and peaceful use of space for whose solution it would in our opinion be important to unite the efforts of nations. Some of them which are encompassed by the recent U.N General Assembly resolution adopted at the initiative of our two countries, are also mentioned in your message.

1 Scientists consider that the use of artificial earth satellites for the creation of international systems of long-distance communication is entirely realistic at the present stage of space research. Realization of such projects can lead to a significant improvement in the means of communication and television all over the globe. People would be provided with a reliable means of communication and hitherto unknown opportunities for broadening contacts between nations would be opened. So let us begin by specifying the definite opportunities for cooperation in solving this problem. As I understood from your message the U.S.A is also prepared to do this.

2. It is difficult to overestimate the advantage that people would

derive from the organization of a world wide weather observation service using artificial earth satellites Precise and timely weather prediction would be still another important step on the path to man s subjugation of the forces of nature it would permit him to combat more successfully the calamities of the elements and would give new prospects for advancing the well being of mankind Let us also cooperate in this field.

3 It seems to us that it would be expedient to agree upon organizing the observation of objects launched in the direction of the moon Mars Venus and other planets of the solar system by radio technical and optical means through a joint program

As our scientists see it undoubted advantage would be gained by uniting the efforts of nations for the purpose of hastening scientific progress in the study of the phy ics of interplanetary space and heavenly bodies

4 At the present stage of man s penetration into space it would be most desirable to draw up and conclude an international agreement providing for aid in searching for and rescuing space ships satellites and capsules that have accidentally fallen Such an agreement appears all the more necessary since it might involve saving the lives of cosmonauts those courageous explorers of the far reaches of the universe

5 Your message contai s proposals for cooperation between our countries in compiling charts of the earth s magnetic field in outer space by means of satellites and also for exchanging knowledge in the field of space medicine I can say that Soviet scientists are prepared to cooperate in this and to exchange data regarding such questions with scientists of other countries

6 I think, Mr President that the time has come for our two countries, which have advanced further than others in space research, to try to find a common approach to the solution of the important legal problems with which life itself has confronted the nations in the space age In this connection I find it a positive fact that at the UN General Assembly s 16th se ion the Soviet Union and the United States were able to agree upon a proposal on the first principles of space law which was then unanimously approved by the members of the UN a proposal on the applicability of international law including the UN Charter in outer space and on heavenly bodies on the accessibility of outer space and heavenly bodies for research and use by all nations in accordance with international law and on the fact that space is not subject to appropriation by nations

Now in our opinion it is necessary to go further

Expansion of space research be ng carried out by nations defini ely makes it necessary to agree also that in conducting experiments in outer space no one should create obstacles for space study and research for peaceful purposes by other nati ns. Perhaps it should be stipulated that those experiments in space that might compl cate space research by other countries should be the subject of preliminary di-cussion and agreement on an appropriate international ba is.

I ha e named, Mr President only some of the que t ons whose solution has, in our view now become urgent and requires cooperation

between our countries. In the future international cooperation in the conquest of space will undoubtedly extend to ever newer fields of space exploration if we can now lay a firm foundation for it. We hope that scientists of the USSR and the U.S.A will be able to engage in working out and realizing the many projects for the conquest of outer space hand in hand and together with scientists of other countries

Representatives of the USSR on the UN Space Committee will be given instructions to meet with representatives of the United States in order to discuss concrete questions of cooperation in research and peaceful use of outer space that are of interest to our countries

Thus Mr President do we conceive of—shall we say—heavenly matters We sincerely desire that the establishment of cooperation in the field of peaceful use of outer space facilitate the improvement of relations b tween our countries, the easing of international tension and the creation of a favorable situation for the peaceful settlement of urgent problems here on our own earth

At the same time it appears obvious to me that the scale of our cooperation in the peaceful conquest of space as well as the choice of the lines along which such cooperation would seem possible is to a certain extent related to the solution of the disarmament problem Until an agreement on general and complete disarmament is achieved both our countries will nevertheless be limited in their abilities to cooperate in the field of peaceful use of outer space It is no secret that rockets for military purposes and spacecraft launched for peaceful purposes are based on common scientific and technical achievements It is true that there are some distinctions here space rockets require more powerful engines since by this means they carry greater payloads and attain a higher altitude while military rockets in general do not require such powerful en ines—engines already in existence can carry warheads of great destructive force and assure their arrival at any point on the globe However both you and we know Mr President that the principles for designing and producing military rockets and space rockets are the same

I am expre sing these considerations for the simple reason that it would be better if we saw all sides of the question realistically We shoul l try to overcome any obstacles which may arise in the path of international coop ration in the peaceful conquest of space It is possible that we shall succeed in doing this and that will be useful Considerably broader pro pects for cooperation and uniting our scientific technolo ical achievement up to and including joint construction of spacecraft for reac1ing other planets—the moon Venu Mars—will arise when agreement on disarmament has been achieved

We h pe that agreement on general and complete disarmament will be achieve l we are exerting and will continue to exert every effort toward this end I ould like to believe that you al o Mr President will spare no effort in acting along these lines

Yours respectfully
N Khru hchev

Mo cow March 20 1962

[13] Full text of the Bilateral Space Agreement between the US and the USSR together with pertinent letters of transmittal and press releases may be found in the *Department of State Bulletin* December 24 1962 p 962 ff

[14] *Op cit* pp 964–965

[15] Full text of the First Memorandum of Understanding to gether with press releases correspondence and appendix may be found in the *Department of State Bulletin* (September 9 1963) p 405 ff

[16] NASA News Media Briefing "Joint US-USSR talks on Cooper ative Space Research Projects Held in Rome Italy (March 25 1963)

[17] First Memorandum of Understanding Section IV paragraph 6

[18] E.g. Robert S Allen and Paul Scott Los Angeles *Times* (January 24 1964)

[19] This meeting occurred privately during the annual reunion of the International Committee for Space Research (COSPAR) The Chief USSR and US representatives were respectively Academician Blagon ravov and Dr Homer E Newell, then Director Office of Space Sciences NASA.

[20] Both achieved in October 1964

[21] "Space U S and Soviet Scientists Get Along on Detailed Planning for Two Cooperative Projects *Science* (April 5 1963) p 39 40

[22] Full text of Sir Bernard Lovell s letter of July 23 1963 to Dr Hugh L. Dryden as it appeared in *The Congressional Record* August 9 1963 p 13903 follows

University of Manchester
July 23 1963

Dr H Dryden
NASA Headquarters
Washington, D C.
United States of America
Dear Dr Dryden

From June 23 until July 15 I was in the Soviet Union as the guest of the Academy of Sciences. During this time I was taken to the major Soviet optical and radio observatories and to the deep space tracking network—a station which has not so far been seen by Western eyes or by many Soviet scientists so I was told. I mention this at the beginning of this let ter because it does seem to underline the apparently genuine desire of the Academy to extend its cooperation with the West

At the request of the president of the Academy (Academician M. V Keldysh) I had two meetings with him and his senior advisers before and after the visit to the deep space facility because he asked me to consider what form of cooperation might be possible between that facility and Jodrell Bank. The e consultations seem to me to have been outstandingly successful in their promise of immediate cooperation and it is my desire to acquaint you with these arrangements and further to draw your at tention to an issue raised by the president of the Acad my in connection with the lunar space program Under (1) I outline the proposals for co operation as far as Jodrell Bank is concerned, and under (2) I convey a

letter of July 23 We in NASA are very glad to have the benefit of your observations and your thoughts with regard to the future interests of Soviet scientists. Your report of a U.S.S R. plan to orbit a manned astronomical platform is interesting in the light of our own project for an unmanned orbiting astronomical observatory a comparison of results could be interesting

It is most encouraging that you have been able to work out cooperative programs covering certain interests in radio and optical astronomy With regard to space research and exploration as you know our present relationships with the Soviet Union have developed directly from the correspondence between President Kennedy and Chairman Khrushchev on specific possibilities of cooperation in this field Dr Dryden s discussions with Academician Blagonravov over the past year or so have followed within this framework. There is already a current agreement between the Soviet Academy of Sciences and NASA which represents the first fruit of these early efforts

Accordingly if the Soviet Academy is indeed interested in the matters you describe in your letter we will look forward to the possibility of further explorations by Dr Dryden and Academician Blagonravov as to their views and desires I will discuss this with Dr Dryden on his return. I assure you that there has been and continues to be a strong desire on our own part to maximize the areas of cooperation between this country and the Soviet Union with the fullest possible participation by other countries.

Sincerely yours,
James E. Webb
Administrator

[24] *Space Daily* (November 7 1963) p 217

[25] E g see *Newsweek* (September 30 1963) "Visit to a Small Satellite? and *Missiles and Rockets* (September 23 1963) Soviets Eye Joint Moon Landing

[26] *TIME* (September 27 1963)

[27] *The Wall Street Journal* reported The President s UN offer of a joint expedition to the moon was clearly prompted by the Administration s recent conclusion that the Russians have been reassessing their own space goals The report went on to say that the first clue to this change came from Lovell and the second from Blagonravov during the luncheon with Dr Dryden (September 23 1963)

[28] E g Congressional comments are reported in the *Los Angeles Times* for September 24 1963 under a headline reading Soviet US Moon Shot Plan Baffles Congress

[29] E g Ira C Eaker in the Cheyenne Wyoming *State Tribune* (October 23 1963)

[30] Letter from the President to Rep Albert Thomas reported in *N Y Times* (Sept 27 1963)

[31] Webb speech before Midcontinent Oil and Gas Association Houston Texas (Sept. 25 1963)

[3] Webb address before the Institute of Foreign Affairs (Jan 24, 1963)

[33] *Congressional Record—Senate* (Aug 9 1963) pp 13904ff

[34] *The Wall Street Journal* (Sept 23 1963)

[35] First Soviet press and radio reports of President Kennedy s UN speech deleted references to his moon proposal (UPI reports datelined Moscow Sept. 20 1963) First comment was an article in *Izvestia* (Sept 28 1963) suggesting that the proposition was premature

[36] Associated Press dispatches datelined United Nations N Y., Sept 21 1963

[37] Associated Press dispatches *Washington Post* (Sept 22 1963)

[38] William Hines in *The Sunday Star* Washington D C (Sept 22 1963)

[39] Jonathan Spivak in *The Wall Street Journal* (Sept 23 1963)

[40] A Lunar Proposal *Missiles and Rockets* (Oct 14 1963) p 52

[41] *LIFE* (October 11 1963) p 100ff

OTHER MECHANISMS for COOPERATION

While the US national space program remains the principal mechanism for effecting international cooperation on an operational level and COSPAR is the central forum for scientific coordination neither the US nor COSPAR has a monopoly on cooperation There are other governmental as well as nongovernmental mechanisms with both operational and nonoperational roles to play The most significant in the operational area are two regional organizations the European Space Research Organization (ESRO) and the European Launcher Development Organization (ELDO) The most significant on the nonoperational side is the United Nations—along with certain of its specialized agencies especially the World Meteorological Organization (WMO) and the International Telecommunications Union (ITU) Numerous other organizations have interests in the same subject areas and often figure in public reports suggesting cooperative activity or potential

THE EUROPEAN REGIONAL ORGANIZATIONS

All of the European nations with the possible exception of France took it for granted from the outset that major national space programs were beyond their financial scope Yet the appeal of entry into space remained strong in official and industrial quarters The basis of this appeal was much the same as in this country though perhaps the European have been more realistic about the values of space activity than we have been here Prestige is of course a consideration

but not the most persuasive one Far more important has been the belief that space activity is an important element in the technological base for economic and military security The lesson of American technical preeminence has not been lost upon the Europeans It is clearly recognized that if science and technology are to move forward in quantum jumps it is by practicing them at their own frontiers Moreover the Europeans have had their eye more firmly fixed perhaps than we do upon the ultimate practical payoffs of space research—communications navigation weather forecasting improvements It was these considerations more than any other which led the principal nations of the continent to enter into governmental agreements for the pooling of their resources in space activity

Such pooling is not unique to space It was already well established in Europe in economic and scientific fields including especially nuclear energy prior to the advent of the space question But its special application to science has been notable because of the increasing complexity and cost of research ' Scientific cooperation in Europe is no longer a marginal activity it represents a major and perhaps the only means for the smaller countries to keep in touch with the rapid advance of science especially in expensive fields [1]

In order that European motivation be fully understood it is important to recognize a distinction between space science and technology An adequate outlet for European *scientific* interests may have existed in the opportunities for cooperation with NASA in the United States. But the Europeans want to master the *technology* of space activity This fact accounts for the support given to the establishment of ESRO and ELDO even though the programs of those organizations must for a considerable time follow in the tracks of the American and Soviet juggernauts The *experience* was what was required and it would not satisfy practical self interest in Europe to delegate the technical jobs to the US While this decision has been characterized as foolish by many it rests on a sound appreciation of the importance of know how in advanced technology know how which cannot be acquired except by doing One Englishman discussing a cooperative US UK project put the point this way

> When we have proceeded with the conception of cooperation in the *technological* field in terms of a sharing of technological experience as opposed to the division of the scientific and technological aspects involved in the forthcoming Scout firings then we shall be making possible a new and immensely worthwhile attack on the large scale problems ahead"

The formal establishment of both ESRO and ELDO came in March, 1964 after more than two years of sharp debate in Europe on the issues noted above ELDO had by far the more difficult sledding Its objective was to pool European efforts to produce a major satellite launcher, although no precise use for it was stated or apparent Nevertheless the participating nations felt there was ground enough for the effort in the technological exercise itself and in the possibilities for using the ELDO vehicle to launch communications satellites or the larger scientific satellites which might be prepared by the sister organization ESRO

Basis for the ELDO booster was the Blue Streak missile put under development by Britain in the early 1950 s in order to create a British nuclear deterrent Both the rocket engines and the rocket structure derived from technological information provided by the United States through industrial agreements The missile effort was discontinued in 1960 as too costly and time-consuming Arrangements were then worked out with the continental powers to utilize the Blue Streak as the first section of a three stage satellite booster for civil purposes" France would provide the second stage and West Germany the third. The Netherlands and Belgium assumed responsibility for much of the electronics, tracking installations and guidance while Italy was to engage in advanced spacecraft design Because use of the major launching range in Woomera Australia was required Australia too became a member

An ELDO Preparatory Commission was established in Paris in 1962[3] It successfully weathered a difficult organizational period during which major responsibilities were apportioned plans for the several stages pressed forward problems of technical compatibility sorted out and industrial contracts let through the member countries —despite funding restrictions which applied until parliamentary rati

is predicated upon a high degree of initial success in the development and testing of the three stages of the booster One may hazard the guess that the costs will ultimately be greater The final booster will be a powerful one falling somewhere between the American Thor and Atlas systems It is hoped that its actual performance will be up to placing a ton and a half payload in a near earth orbit The facilities developed for its testing and operational launching at Woomera (largely for the earlier missile program) are comparable to those for Atlas launchings at Cape Kennedy with the added advantage of a very long (1 000 miles) over ground test range

The ELDO program in principle presents the United States with a problem central to space cooperation Because ELDO is devoted entirely to rocket development any relationship between ELDO and the United States must rest squarely upon technical cooperation in this field Earlier NASA as the agency charged with cooperation in space for the United States had avoided missile-related security difficulties by stressing cooperation in scientific payloads and spacecraft Yet ELDO cannot be blinked it represents an additional opportunity to extend cooperative relationships particularly in light of its charter provision excluding military purpo -s and espousing civil applications only Clearly then cooperation with ELDO either directly or through the authorization of commercial relationships must find a valid dividing line between technical exchange which contributes to military applications and such technical exchange as falls short of the military A superficial view and one quickly assumed by the lay observer is that a missile is a missile technical assistance for a scientific satellite booster will not preclude the use of that booster for military purposes Actually this will depend very much upon conditions and circumstances Generally speaking missiles using cryogenic fuels for example do not commend themselves for use with deterrent forces since it is too difficult and expensive to keep them in a stand by status storable propellants are much to be preferred Thus fuels and other missile elements requiring the use of cryogenic equipments are unlikely to be used for weapon systems Similarly certain guidance systems are adequate for space applica-

tions but do not commend themselves for targeting applications It is perhaps sufficient here to say that the matter is most complicated but that distinctions appear possible and have in fact been made As a consequence an area of uncertain dimensions one beset by difficult regulatory problems may be assumed to exist for cooperation between ELDO and NASA

The Department of State has stated a general policy governing this area making clear that cooperative undertakings including the export of technology would depend upon the differentiation of civil from strategic applications and would preferably move through the multinational channel of ELDO rather than bilaterally [4]

The present planning of ELDO is substantially limited to completion of a first configuration of the Blue Streak satellite launcher system On this relatively little mutual interest can be based since the program is essentially a re tracing of technology already existing in the United States But while ELDO pursues its first program it is casting its eyes also to the future to upgrading its system and to entering into andvanced space technology Here then may lie mutual interests

ESRO devoting itself entirely to scientific satellites and sounding rockets presents no such obstacles to international collaboration with the United States The decreased sensitivity of this enterprise is apparent in the fact that some of the neutral nations of Europe joined with the leaders to bring the total membership of ESRO to nine nations, Belgium Denmark Federal Republic of Germany France The Netherlands Spain Sweden Switzerland and the United Kingdom, with Italy delayed only on technical grounds [5] ESRO like ELDO worked out a prospective program on a multinational basis while existing only as a Preparatory Commission Its level of effort established at some $300 000 000 over eight years the preparatory group proceeded to plan for the establishment of headquarters in Paris, a technical center [6] a data center in Darmstadt a sounding rocket range in Kiruna (Sweden) and a satellite tracking and data acquisition network in several widely scattered locations

By pooling their resources ESRO s members felt they might

carry out a scientific sounding rocket program with about 60 or more launchings per year over two thirds the NASA rate As for satellites they counted on perhaps two satellites per year after the fourth year of the program with near earth researches first and then perhaps astronomical or lunar observatories as it might become possible to look to more ambitious undertakings

NASA early welcomed the efforts to organize ESRO Dr Dryden, NASA s Deputy Administrator, wrote to Sir Harrie Massey, President of ESRO s Preparatory Commission, in May, 1962 to express this welcome and offer to ESRO the same terms for cooperative activity which applied to bilateral relationships Thus ESRO was invited to send trainees for assignment in NASA centers or in graduate programs in US universities the possibility of joint satellite projects was held out as well As it has developed an increasingly close relationship between ESRO and NASA appears assured A dozen European trainees were accommodated at NASA s Goddard Space Flight Center during 1963–64 for work in satellite engineering in anticipation of joint satellite projects ESRO sponsored each year beginning in 1962 an increasing number of graduate students from all over Europe for training in US universities engaged in space research under NASA grants or contracts Arrangements were worked out for an exchange of services in connection with bibliographic and documentation activities with the result that a single publication will report and abstract most of the literature of interest in both the US and Europe for both organizations Perhaps most important ESRO circularized its member nations for proposals for the first European satellite experiments drafted proposals for two satellites which would be engineered in Europe and asked NASA to consider launching them With technical approval in the Spring of 1964 by NASA s Office of Space Sciences and Applications a truly multinational pace program was a sured

At the same time ESRO a ked for support from the NASA network in the tracking of atellites and the acquisition of data from them (Such inquiries had come from other interests as well) But NASA s network had been e tabli hed to meet dome tic requirements little

excess capacity existed for the support of other programs More over, the uncertainty of schedules in space programs—characterized always by new developments and the most advanced technology—meant that neither party to a cooperative arrangement could guar antee its own schedules, the result would be slippages and resulting conflicts in schedules making commitments impossible NASA could say no more therefore, than that it would give tracking and data acquisition assistance to ESRO to the degree that time was available and equipments compatible While this could indeed be important, it fell short of ESRO s obvious requirement for support upon which it could count for its various projects Accordingly ESRO accepted the necessity for establishing its own network, but in order to profit from the possibility of assistance from NASA, determined that its network should be compatible with NASA's Thus each side would be able to assist the other in emergencies and otherwise

In laying out its network plans ESRO found that Alaska was well suited for the location of one of the European data acquisition sta tions The US was then presented for the first time with a request which would allow it to reciprocate for the numerous instances in which our own overseas requirements for tracking stations had been accommodated by other nations The US agencies which were con cerned in the Alaska reque t—not only NASA but the Federal Com munications Commission the Department of State the Interdepart mental Radio Allocation Committee and the Department of Defense —were quick to recognize the implicit obligation to do all possible to assist ESRO (US law does not permit foreign nationals to transmit radio signals from our territory—with the single exception of foreign embassies—and so appears to preclude the reciprocal extension of privileges we regularly seek from other countries However with the sympathy and understanding of all concerned it seems possible to make suitable provision for a foreign station if a US contractor is given authority over the use of its transmitters On this basis the proposed Alaska station may go ahead without difficulty One may hope however that it will become possible to amend the law so as to facilitate extension of transmission authority to foreign nationals on a

reciprocal basis in connection with experimental scientific activities, and where there is a competent sponsoring governmental authority in this country such as NASA)

Apart from cooperative programs with NASA, ESRO naturally looks to ELDO for major launch capabilities but these are far off perhaps 1967 or later Moreover the ELDO launch vehicle is suited only to heavy earth satellites or to probes to the moon and beyond Between the small earth satellites which may be done in cooperation with NASA and the larger ones appropriately fitted to the heavy ELDO booster there may be a need for middle weight scientific satellites The purchase of US boosters like Thor Delta may be appropriate for this purpose Such arrangements are possible under curren policy and can bring far greater flexibility to ESRO s program thar would otherwise be the case

The costs of the two regional European space organizations are apportioned among the member states with the United Kingdom bearing the heaviest burden something in the neighborhood of two fifths of the total France and Germany sharing roughly another two fifths and the other nations splitting the remainder The fact that space science and technology have brought these practical and hard headed governments together to shoulder two programs representing more than a half billion dollar investment over eight years is evidence enough of the value which they attach to space activity Certainly the dominant political and industrial interests in Europe believe strongly in these activities and the benefits which may follow from them Moreover the participating nations have concluded that the benefits can be realized only through collective action—evidence of the unifying forces inherent in the massive technologies of the future

The order of investment nevertheless is far from comparable to *that by the United States Whereas we are investing over one percent* of the gross national product in space research and exploration no European country is investing even a considerable fraction of this percentage of its GNP in space activities France is the most energetic and aggressive nation in this regard but its expenditures on space are

probably well under one tenth of one percent of GNP Thus the total effort in Europe despite pooling of resources is far below that in the United States, a fact which it is well to keep in mind when assessing the full potential of cooperation between NASA and ESRO/ELDO Valuable individual and specific technical exchanges and cooperation may be had together with valuable political impact, but no large scale sharing of major research and development programs is yet in view

THE UNITED NATIONS

The United Nations is our most comprehensive international political organization and space science is one of the most complex sciences in terms of its social requirements Therefore it should not be surprising that each has taken notice of the other [7]

The United Nations first approached the problems of outer space through disarmament A resolution of the General Assembly a few days after the second Sputnik was launched in November, 1957 urged an international convention on disarmament and a nuclear ban Included among its objectives was The joint study of an inspection system designed to ensure that the sending of objects through outer space shall be exclusively for peaceful and scientific purposes' [8] This action was taken as a consequence of proposals put forward by Ambassador Lodge for the US during the previous month Lodge reminded his UN audience that the US had proposed to internationalize atomic energy at a time (1946) when it alone had nuclear weapons he then said We now have a similar opportunity to harness for peace man s new pioneering efforts in outer space We must not miss *this* chance We have therefore proposed that a technical committee be set up to work out an inspection system which will assure the use of outer space for exclusively peaceful and scientific purposes [9] The Soviet Union objected to the resolution without success, and later advanced proposals of its own to ban the military use of space [10] The difference between the two sides was that the US was willing to negotiate on the subject of outer space and missile controls with

out regard to other issues whereas the Soviet Union declined tc separate this matter from questions such as US military bases on earth

In any case the objective of 'peaceful uses of outer space as stated by the United States became the focal point for UN considera tion of space matters However, the theme underwent a subtle transition Since the UN could not *restrict* outer space to peaceful purposes it shifted its efforts to *encourage* peaceful activities In following this line in the next half dozen years the UN had to work out two problems First was a long series of political difficulties be-tween East and West in connection with the establishment of a UN Committee on the Peaceful Uses of Outer Space The second was the task of determining just what the UN s proper role might be in space matters and what such a UN committee might do if and when estab lished

Both problems were joined when the General Assembly passed a resolution in December 1958 to establish an Ad Hoc Committee on the Peaceful Uses of Outer Space [11] The resolution expressed a wish to avoid the extension of present national rivalries into this new field,' noted "the success of the scientific cooperative program of the International Geophysical Year in the exploration of outer space and the decision to continue and expand this type of cooperation" and endorsed continuing cooperation The Ad Hoc Committee was asked to report on the resources of the UN complex and other inter national bodies on outer space matters and to indicate appropriate areas for the UN to work in what organizational arrangements within the UN *framework* might *facilitate* cooperation and what *legal* problems might be expected to arise from space activity

The resolution was supported by both the leading space powers but they parted company when it came to determining the composition and leadership of the Ad Hoc Committee Of the eighteen member na tions, three Soviet bloc countries boycotted the Committee and two neutrals (India and the UAR) abstained on the ground that nothing could be accomplished without both the US and the USSR partici pating Nevertheless the Committee met and prepared a report This

the way for Soviet participation in a broadly supported UN effort to contribute to international space objectives The political issues had narrowed down to the method of reaching agreement within the committee the committee s composition and its leadership The Soviet Union wished the committee to act only by unanimous con sent, the US refused to abandon the UN General Assembly practice of majority rule This matter was compromised with an understand ing that without prejudice to recourse to majority vote the commit tee would do its best to reach a concensus without the need for voting The composition and leadership issues were resolved by the addition of several states swelling the committee s total to twenty eight and by the selection of Committee officers representing West ern Bloc and non aligned countries The result was another General Assembly resolution (1721) [13] now the basic UN document in the space field This resolution

√ Commended to member states two principles International law including the UN Charter applies to outer space and celestial bodies both space and celestial bodies are free to all and are not subject to national appropriation

√ Invited the Committee to report on legal problems which might arise from the use of space

√ Asked member states to report space launchings to the UN for a public registry

√ Requested the Committe on the Peaceful Uses of Outer Space to
  - —maintain contact with other space organizations
  - —provide for exchange of information voluntarily supplied by governments but without duplicating existing scientific and technical channels
  - —study measures to promote cooperation in space

√ Asked the WMO to report on the advancement of weather research and forecasting techniques with special reference to space developments.

Asked the ITU to report on opportunities and actions to prepare the way for the expected benefits promised by communication satellites, and asked UN technical assistance agencies to assist member states to develop their domestic capabilities for taking advantage of such benefits

The new Committee on the Peaceful Uses of Outer Space met briefly for the first time in March 1962 in New York Recognizing the essential division of its interests it provided for two subcommittees one on Legal problems the other on Scientific and Technical matters The new Chairman expressed the consensus of the Committee that its function was necessarily one of encouragement and facilitation rather than operation

The work of the Committee was at the outset unexpectedly successful on the technical side where only limited objectives were sought. It was more difficult and slow going on the legal side where broader objectives were attempted But even here progress has been made

The Scientific and Technical Subcommittee met in Geneva in May 1962 The Subcommittee unanimously recommended the publication of information on national space programs, as well as technical information of interest to nations beginning space research It solicited support for certain activities of the world scientific community and it asked for UN sponsorship of an international sounding rocket range to be established on the geomagnetic equator

Both the parent Committee and the General Assembly gave their blessing to this modest program Positive results have been forth coming COSPAR and UNESCO have been induced to collaborate in the preparation and publication of certain documents expected to be of use to nations turning to space research for the first time India promptly came forward to offer the range at Thumba for international use under the terms provided by the Subcommittee *(See also p 62)* A special UN committee subsequently inspected the Indian range at Thumba and recommended its sponsorship by the United Nations. France and the USSR have pledged contributions (of equip

ment) to the range to complement those already made by the United States

The first joint US French and Indian experiments were successfully conducted at Thumba in the early months of 1964 Here perhaps a basis may have been established for the first intimate association of eastern and western technicians in the conduct of space research although within the limited context of small sounding rocket projects

One potentially difficult and even disruptive question put to the Subcommittee was resolved in such a way as to minimize its political and maximize its scientific consideration The question related to international consultation prior to the conduct of space activities which might cause harmful effects or interfere with other scientific investigations Rather than treat such matters in the political atmosphere of the UN the Subcommittee chose to rely upon COSPAR—inasmuch as COSPAR had established a Consultative Group designed to attack questions of this kind through objective expert and quantitative analysis

The Scientific and Technical Subcommittee reconvened in Geneva in mid 1963 but little more was accomplished The Subcommittee agreed that the secretariat should try to assemble background information for the use of members for example on opportunities for technical training—a matter of some interest to the less advanced countries But even relatively simple proposals met heavy going An illustration was a British proposal that the Secretariat act as a clearing house bringing requests for training together with opportunities for training although final arrangements would be made directly between the countries concerned Since the Subcommittee sought to operate on a unanimous basis Soviet opposition was sufficient to defeat this quite simple plan despite wide support from the other countries represented In general the absence of progress at this meeting may be ascribed in part to Soviet inhibitions but also to the limited scope available for UN activity within its prescribed non operational function

The 1964 meeting of the Subcommittee repeated in large part the

experience of its predecessor, although progress was now begun in some of the matters snagged in earlier sessions Thus the clearing house function of the Secretariat in training matters was finally endorsed However political issues continued to raise their heads the Soviet Union registered strong objections for example to factual reports regarding the new European Launcher Development Organization because West Germany was a member, and the Soviet felt "no assurance that Germany would not use the missile technology it might gain through ELDO for military purposes (Of course there was no such assurance from any nation except as it had stated its intentions and ELDO was pledged to civil applications only) It was apparent that the Scientific and Technical Committee would continue to operate in a heavily political atmosphere

The first sessions of the Legal Subcommittee were considerably more frustrated than the first very productive meeting of the technical group In a sense the background was less well defined and more political With man extending himself into space without benefit of markers boundaries or rules a wide spectrum of views exists as to the possible legal complications At one extreme is the happy notion that space activity having progressed for some years without benefit of legal regulation or principle now requires none At the other extreme is the notion that not a moment s further use of space can be made unless the legal fraternity by thorough and careful prescription, first removes the totally disabling uncertainty as to where we stand legally As in most such antitheses the truth undoubtedly lies somewhere between On the one hand it is perfectly correct that about two hundred satellite launchings have taken place over the better part of a decade without legal question If one includes international participation in NASA satellite projects and the initial test launchings of ELDO some eleven countries are already involved in launching objects into outer space Well over a dozen countries are launching small sounding rockets into outer space Some 38–40 countries are participating in tracking and data acquisition from satellites either directly or through the accommodation of another country s stations and often under government to government agreement An

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even larger number of nations have interested themselves in the satellite work of the experimenting countries an international organization of multinational participation in communications satellite systems is in being There is little question then that a very considerable consensus regarding the legitimacy of space activity has been established *in fact*

On the other hand numerous fragments from decaying space objects have impacted the earth—so far without verified damage or injury (although Cuba has claimed the undoing of a cow) Both the US and USSR are reported to have conducted nuclear tests in outer space and there have been objections by scientists to one US project in which copper filaments were deployed in space to act as a radio *communications reflector Although these objections were discredited* by the demonstrated harmlessness of the project in fact[14] and by a clean bill of health from COSPAR [15] the question of unilateral interference remains in principle Moreover we face a time in the near future when men shall have landed upon the moon although both the US and the Soviet have frequently disclaimed any intention to assert sovereignty over the moon such disclaimers may vary in quality and circumstance Perhaps *most important, the increasing frequency* of manned flight inevitably brings closer the day when emergency or accidental landings will raise questions of recovery and repatriation Thus there is litttle question that some thought and action are required to handle legal issues which may reasonably be thought to be close at hand

How close at hand was dramatically brought home by a circumstance during a United Nations discussion in the fall of 1962 Some difference of view had been expressed by Soviet and American representatives as to the immediacy of legal questions concerning the recovery of astronauts and liability for damages During the course of these discussions word reached the US delegation that moon watch teams of the Smithsonian Astrophysical Observatory had recovered an object on a main street of Manitowoc Wisconsin following the re-entry of fragments from a Soviet sputnik [16] The object was positively identified as man made and as having been in outer

space Its recovery, still warm in the area of the sputnik s re-entry from space left no doubt as to its origins and identity Close to a foot in diameter and several inches thick the steel fragment also left its mark upon the Manitowoc street where it fell The object was introduced by Ambassador Francis Plimpton US Delegate to the UN Committee on the Peaceful Uses of Outer Space just after his Soviet colleague had expressed doubt as to the immediacy of the question of liability for damages which might be caused by objects returning from outer space [17]

The incident reflected an early division betweeen the US and Soviet Union—whether to proceed with the two matters believed by the US to be of immediate concern (liability and recovery) or to attempt to frame all-embracing legal principles for the total space problem Apart from the doubt expressed by the US regarding the general readiness to enter into the larger task so early in the space age the question of a legal code was complicated by the fact that the USSR wi hed to include in it a number of provisions which were plausible enough but objectionable in fact These would include bans on surveillance by 'spy satellites [18] on the use of satellites for propa ganda" and on the launching or use of satellites by any but govern ments also the Soviet side suggested what amounted to the right to veto experiments which might possibly interfere with another nation s space research The United States maintained that surveillance satellites were not aggressive weapons that a ban upon propa ganda broadcasts of any kind had already been agreed to by the Soviet Union in another forum but then withdrawn (besides posing a question far broader than space applications alone) and that the US could not agree under our private enterprise system to fore close the commercial use of satellites (such as might be made under government regulation by common carriers in a communications net work) Finally no one seriously believed that the Soviet Union would itself submit to a veto upon space experiments or that it would in any case volunteer the information that a Soviet experiment might possibly interfere with other space activities

The two viewpoints were compromised by combining the two mat

ters of immediate interest (liability for damages and recovery arrangements) with the broader principles suitably modified The result embodied in Resolution 1962 in the late fall of 1963 restated the principles that international law applies in outer space and that no state may appropriate celestial space or bodies to its own use The resolution went on to say that states are responsible for their national activities in space and must supervise activities by non governmental agencies that states launching or arranging the launching of objects into space are liable for damage or injury caused by those objects that states of registry retain jurisdiction and control over such objects and personnel and that there is an obligation to return space objects and personnel to the state 'of registry wherever they have gone astray by reason of emergency or accident International organizations were to be responsible under the legal code along with their member nations (This was to become a sticky matter in subsequent more detailed deliberations) International consultation was prescribed for any nation which had reason to believe that a prospective space project might interfere with the space activities of other nations

The next task for the Legal Subcommittee was to attempt the elaboration of international conventions detailing the responsibility and obligations of nations in the two most immediate matters recovery and return of spacecraft and their occupants, and liability for damages or injury Considerable progress was made toward these ends in the Spring of 1964 in Geneva but it was necessary for further work to be done

Two issues thought to be of high importance in some quarters were not seriously debated in the United Nations proceedings First was the question of defining the boundary betweeen air space and outer space The second was a definition of peaceful uses The importance of the first issue derives from the fact that national sovereignty includes the air space above a state s territory but by general resolution of the United Nations and the practice of space faring nations does not extend into outer space Where does one leave off and the other begin? Numerous arbitrary and natural boundaries

have been suggested generally set at 25 or 50 miles above the earth or fixed at the limits to which aerodynamic lift can be obtained (that is where aircraft can fly) [19] The difficulty is that technology itself is dynamic and that yesterday s low orbiting or high lift limits may change today and again tomorrow Even the density of the atmosphere (and therefore its lift characteristics) at any given level changes with diurnal and seasonal cycles In any case the United Nations discussions do not reflect serious concern over this matter at this time and it remains a critical item only in the view of a few Other experience suggests that the legal definitions of both air and outer space are inseparable from the capacity to use them or deny their use

The smaller nations in the UN have repeatedly vented their view that the use of space should be limited to peaceful purposes broadly defined (broadly defined in that peaceful is used as the antithesis of military rather than only of aggressive" as used in the UN Charter) Since for the most part the smaller nations are engaged in no use of space at all this viewpoint is easy to come by, to understand and even to sympathize with The matter is more difficult for the United States because activities openly carried on in space by the US military are understood so far to have involved no weapons systems and to have no aggressive character The United States therefore considers them entirely peaceful (Indeed it is readily conceivable that surveillance activities now reported to be conducted by the military of both the US and the USSR could make a significant contribution to peaceful purposes if some day carried out by or on behalf of an international authority) In contrast the interests and activities of the Soviet military in space are totally clandestine Accordingly they have not presented as convenient a target as the relatively open business of the American military As a consequence the Soviet has not often been called upon in the UN to answer for military activities which must be assumed to parallel or exceed those of the United States Nevertheless the Soviet is conspicuously reluctant to support the efforts of smaller nations to impose a ban upon all space activities except those for "peaceful purposes While the non spacefaring

nations have made little progress on this point it may safely be assumed that they will pursue their objective having nothing to lose and perhaps something to gain in seeking some restriction of space activity to peaceful purposes At bottom however, the matter must be *linked as the US has said to disarmament discussions rather than* to space alone and must rest upon some verification procedure Otherwise an endorsement of peaceful purposes only is mere cant

Another area in which international accord is required for the orderly conduct of space research and applications is the allocation and use of radio frequencies questions which are of concern to the International Telecommunications Union (ITU) a specialized agency of the UN Several years of careful preparation were required by telecommunications experts the world over in anticipation of an Extraordinary Administrative Radio Conference of the ITU to Allocate Frequency Bands for Space Radio Communications convened in Geneva in October and November 1963 The task was to make adequate provision for space research tracking and telemetry on the one hand and on the other to provide for the future expected use of the radio frequency spectrum for various space services including satellite meteorology navigation and most importantly telecommunications Since the radio spectrum is already heavily encumbered by existing services of one kind or another serious if not fatal difficulties could have been posed had not the nations come to a consensus on the necessary allocations for immediate use as well as future uses that may reasonably be expected to materialize The United States reflected relatively bullish sentiments for the future of space radio uses and wished to provide for them in a liberal and comprehensive fashion Other countries took a more conservative view of future needs and were more reluctant to rearrange existing allocations to accommodate them Nevertheless an apparently very satisfactory series of allocations was made representing agreement by all the major nations including the Soviet Union

A summary of the Conference s actions was read into the Congressional Record by Representative Harris of Arkansas who was a participant[22] Mr Harris noted that

> The Conference agreed to set aside 2800 megacycles for communications satellite services The United States had proposed 2725 megacycles while the Soviet proposal was limited to 1600 megacycles
>
> For the most part the Soviet proposal was in frequency bands different from those proposed by the United States Only 800 megacycles were common to both proposals
>
> Under these circumstances it is most gratifying that the 2800 megacycles agreed to by the Conference include four 500 megacycle bands which were contained in the U S proposal
>
> Apart from the question of the number of frequencies to be allocated for space communications the Conference was called upon to consider the procedure to govern the use of the frequencies thus allocated Several countries including the Soviet held out for provisional use only of the allocated frequencies pending a future planning conference The US position was that the use of the frequencies had to be sufficiently definitive to permit long range planning and major investments in a global communications atellite system Thanks only to the diligent efforts on the part of our delegation to persuade other nations that they too would stand to benefit from the establishment of an early system did the Conference reach the decision permitting immediate use rather than provisional use of the allocated frequencies

Another of the specialized agencies of the UN the World Meteorological Organization (WMO) has been diligent in exploring and attempting to provide for the special opportunities which the space age brings to the international collection of weather information The launching by NASA of the remarkably successful TIROS series of satellites to observe cloud systems and radiation balance both key indices of weather made it obvious that both weather foreca ting and research must now take the satellite fully into account The fundamental questions to be solved are these How can satellite sy tems which only one or two countries can afford and launch be integrated with the conventional weather ob ervation exchanges conducted by the generality of nations? What is to be WMO s coordinating role in this process? Recognizing that enormous quantities of data are gathered by weather satellites what communications arrangements can and must be made to handle their dis emination within the framework of international meteorological data exchanges?

For several years these questions have been considered in the councils of the WMO Necessarily the US and Soviet representatives have had a special role in these discussions and there have been both formal and informal attempts to reach a meeting of minds. Since however the US TIROS program was in existence and open while the Soviet side spoke only vaguely of future plans the consensus was necessarily highly generalized Ultimately the WMO took the position that the development and use of meteorological satellites had to be left to the launching nations with the expectation that the information they obtained would be contributed along with conventional data for further distribution in accordance with WMO practices and recommendations

This position was consistent with the developments which occurred almost simultaneously in the Dryden Blagonravov channel. *(See Chapter III)* Here the ground was laid for bilateral underwriting of the satellite portions of a global operational weather system but with due consideration to WMO objectives This has left WMO relatively free to concentrate on its broader interests in an expanded global weather system for the future in which satellites will be only one element The WMO at the request of the UN Committee on the Peaceful Uses of Outer Space has reported regularly to the Committee on its progress

An overview of UN space activities suggests the following conclusions From a rather poor start heavily snarled in political obstructionism the United Nations complex has moved forward slowly but steadily to make a few very real contributions to the orderly international use of space Certainly the agreement reached for radio frequency allocations for space use represents a solid achievement and the fulfillment of a real requirement The endorsement of an international launch site in India is also valuable technically and politically And the progress toward international conventions on liability and spacecraft/astronaut recovery is heartening The Soviet Union has joined increasingly in this activity to a degree that was quite unexpected Yet care must be exercised lest the substantive value of the progress made to date be overstated Moreover the scope for

further contributions may be limited though it is too soon even to say this The most fruitful possibilities for future UN action may be found to fall more in the legal and regulatory field than in the technical field And the basic import of the technical and legal accords obtained so far in the UN itself must in good part be left to the long term to assess for it may lie as much in the fact of agreement between east and west as in the content of that agreement.

OTHER AGENCIES

A unique mechanism for international understanding the annual Pugwash conferences have attracted much attention, but it may be doubted whether the public differentiates betwixt these private and unofficial conferences and the official but nongovernmental conferences of say, COSPAR, or the official and governmental conferences of the United Nations or whether there is much awareness of the respective roles and limitations of these various organizations.

The Pugwash meetings stem from the private initiative of Bertrand Russell who addressed a letter in July 1955 to prominent scientists asking them to meet 'to appraise the perils that have arisen as a result of the development of weapons of mass destruction ' Requiring only support for travel to the meeting place many of the recipients of the letter journeyed to Pugwash Nova Scotia, where they were accommodated by an American industrialist, Cyrus Eaton The meetings have been held each year since 1955 most often in Canada but also in Austria, the Soviet Union, the United States Britain Yugoslavia France and Italy In the Vienna meeting their third the assembled scientists issued a declaration stating

> Scientists are because of their special knowledge well equipped for early awareness of the danger and the promise arising from scientific discovery Hence they have a special competence and a special responsibility in relation to the most pressing problems of our times.

Much has already been written by able commentators on the basic assumption involved in this declaration—with the result that the role

and competence of individual scientists with respect to major public issues, even technical ones, may be better understood and more humbly conceived today than half a dozen years ago

A frequent participant in Pugwash meetings H Bentley Glass, has observed that,

> On the international scale, scientists have become very active politically Disarmament and arms control negotiations are now conducted by scientists teamed with diplomats although currently their success is none too obvious The trouble seems to be that often scientists engaged in such efforts have forsaken the scientific approach to the problem at issue [21]

Glass feels that the Pugwash meetings offer more hope than does assistance by scientists in diplomatic meetings because they make use of the international character of science and the objectivity of its practitioners "[22] Does specific competence carry over from the laboratory to the resolution of public issues arising from the products of the laboratory? Do the individual or collective opinions of scientists on public issues exert a positive influence upon their governments?

Answers that must give pause have been provided by many Albert Wohlstetter[23] notes that Bertrand Russell's initial call to Pugwash began with the sentence, 'I enclose a statement signed by some of the eminent scientific authorities on nuclear warfare" but none of the ten eminent scientists listed had done any empirical study of military operations likely in a nuclear war." The distinction between technical competence and the larger problems raised by technical developments is real and does not need to be stressed Wohlstetter makes two additional important points: First he remarks

> Questions of military worth are broader than physics and in some ways harder They of course are not purely military questions any more than they are purely technological They may involve a forbidding nest of problems including political and economic as well as military and technological questions However, on the questions that have called for systematic analysis [illegible] cally there has been no experience that was precisely relevant For these questions relate to a near or distant future affected by novel techniques and political uncertainties Experts are seldom "expert beyond experience," and analysis is needed not to replace intui

tion, but to sharpen and supplement it and to make it more public and verifiable

His second point is the following

> The scientists have been very far from agreement In retrospect their views since World War II on major strategic issues—the feasibility and usefulness in deterring or fighting a war of active or civil defense of the ability to bomb enemy industry or cities or military forces of tactical nuclear weapons of restraint in nuclear war and many others—show an extraordinary sequence of sudden and repeated reversals The principal factions of scientists have remained in opposition—sometimes, however almost exactly changing place Moreover the thought devoted to defining these issues and the evidence gathered for resolving them in no case warranted the certainty with which opposing views were propounded This is not to say, of course the politicians and the generals with whom the physical scientists are contrasted, have been right. It would be hard to show however that the scientists have been on the whole more realistic or more prescient. Moral certainty and feelings of prescience have been a pretty uncertain guide to the future—even to the immediately next future beliefs of the prophets

Assuming competent and objective contributions, to what extent can scientists acting unofficially influence their governments? In the United States the technical requirements of three wars, together with the pluralistic character of our society, have brought into being an organizational and representational complex which gives scientists unparalleled access to government It may indeed be assumed that positions adopted by respected scientists in Pugwash meetings can be brought to official notice in this country and may receive consideration commensurate with the support attached to those views by the scientific community In the Soviet Union, the facts may be otherwise It may be doubted that views differing significantly from official Soviet policy will be volunteered at all in Pugwash or in other similar meetings by Soviet scientists Nor can it be expected that Soviet scientists will subscribe to views initiated by the scientists of other countries when these conflict with domestic policy It is difficult, therefore, to understand what mechanism can in fact exist in the Pugwash format to seek or reach any consensus which is different to begin with from Soviet policy Of course Soviet scientists may be individ-

ually impressed with argumentation heard during their participation in these meetings and may carry these arguments home for considera tion We do not know what machinery may operate to this purpose in the Soviet Union nor how effective it may be We can only assume that it may be far less effective in a totalitarian society than in our own [24] The effectiveness of Pugwash is likely to be limited then in the same degree that freedom and objectivity of discus ion may be limited behind the Iron Curtain It will be further limited by the degree to which the participants (principally those from the West) represent themselves rather than organized or official views

A summary evaluation was provided perhaps inadvertently, by an American scientist attending the 1963 meeting in Dubrovnik He was quoted by the press as suggesting that This is the first Pugwash meeting during which the Governments have mirrored the trend of our talks [25] (Since this was the *eleventh* meeting some measure of the effectiveness of the program may be inferred) Among the illus trations of Pugwash effectiveness he cited was President Kennedy s proposal for manned lunary cooperation put forward in the United Nations a few days earlier The President s proposal was said to re flect a suggestion broached ' at the Pugwash conference of 1961 In fact the 1961 conference framed a proposal for cooperation in the *instrumental* study of the moon rather than in its manned explora tion It may be stated with confidence that no causal connection existed between the Pugwash meetings and the Kennedy proposal Careful review of the proposals of the 1961 conference the most ex tensive in the space field suggests quite clearly that they *reflected* rather than stimulated consideration of propositions for possible cooperation Periodic international symposia on the physics of space and the effects of the space environment on life were recommended—but were already being carri ed out regularly in the conferences of COSPAR and the International Astronautical Federation Exchanges of information on these items as well as on methods and instrumenta tion were recommended—but had been sought through the IGY and COSPAR forums for six years The already scheduled plans of the ITU to rationalize the use of radio frequencies for space purposes

were supported The common use of USSR and US tracking stations was recommended but had already been proposed by NASA s Ad ministrator Programs for the International Years of the Quiet Sun and the World Magnetic Survey already planned were urged World wide systems of communications and meteorological satellites then already in the experimental stage and long publicly discussed and planned were endorsed n principle And a symposium on avoid ance of contamination of extraterrestrial bodies was advocated—although a COSPAR group (CETEX) on the broad subject of con tamination had already and unsucces fully sought Soviet participation on this matter Thus it cannot be said that Pugwash was plowing new ground in the space field or that it was contributing significantly to discussions already under way in other forums Indeed the in terest in reaching a consensus had obviously reduced the discussion on space matters to the lowest possible denominator More recently, Pugwash has issued only very brief statements on space and seems to have left the subject to the direct bilateral relationship between the United States and the Soviet Union

The conclusion which suggests itself is not that Pugwash should be abandoned or ignored Nothing is lost through such discussions and confrontations and it remains entirely possible that something of value may well issue from them The process is undoubtedly educa tional not necessarily in achieving better understanding in the sense of increasing sympathy but in the sense of better understanding of the objective realities encountered by scientists in negotiating heavily political matters If the Soviet Union is indeed mellowing the chances of effective communication from scientists to government should in crease correspondingly and should be encouraged and facilitated. But the character function and utility of such forums should also be well understood

* * *

At the opposite end of the spectrum from Pugwash, a remarkable early success has been achieved in establishing an international co operative structure based upon joint governmental and commercial interests in the field of communication satellites Following the initial

demonstration by NASA and its contractors of the feasibility of such satellites, the United States Congress passed the Communication Satellite Act of 1962, providing for a Corporation to function as the US element in a future global system In what was at first a reluctant partnership which then functioned more effectively than could have been expected the Corporation and the Department of State undertook exploratory meetings with technical and governmental authorities in the countries which were most likely to become early participants in such a global system

The issues which were met were quite understandable The desire of the United States to proceed with dispatch to exploit the technical competence which had been achieved in this country di quieted the advanced European countries. They, quite naturally wished to be more than bystanders in the development of a commercial communication satellite system and they wished to participate in all phases of the effort from the beginning The need to get on with an increase in world communications capacity the logic of proceeding from the technical base already established in the United States, and the willingness of the US Corporation to accept at the outset the concept of an international committee under which it would function as a management entity all this helped to bring about an agreement

On July 24 1964 representatives of Au tralia Belgium Canada Denmark France Germany Ireland Italy Japan the Netherlands Switzerland, the United Kingdom the United States and the Vatican City State initialed two related agreements establishing Interim Arrangements for a Global Commercial Communications Satellite System

The first agreement is at the governmental level and provides the organizational principles for the international sy tem The agreement announces a common objective to provide non discriminatory communications services of an advanced type on a global basis conforming to principles laid down in the United Nations The cooperation of the parties is to cover all phases from design to operation The parties designate repre entative communications entities to enter into traffic agreements and an Interim Communications Satellite Com

mittee is set up to give effect to the cooperation envisaged Representation is provided on the basis of agreed quotas or shares of the total estimated cost of $200 000 000 for the interim program and voting is arranged accordingly Decisions are to be made by majority vote but a list of fourteen subjects of more than ordinary interest is set out as requiring a greater degree of concurrence by the heavier investors Not later than January 1959 and hopefully much before the Committee is to report its recommendations for definitive arrangements for a system to supersede the Interim Arrangements (A specific question put to the Committee in this connection is whether it should continue as a permanent entity or should give way to an international organization with a General Conference and an international administrative and technical staff The future decision on this matter will be remarked by those interested in the most effective mechanisms for international activities) The initialing authorities formally signed the interim agreement on August 19, 1964 after which it was to remain open for six more months for additional signatures

The second or special agreement deals with the commercial financial and technical operations of the interim system and is signed by operating communications entities governmental or otherwise In particular the special agreement provides considerations which will determine the acceptance of ground terminals (earth stations for satellite communications purposes) into the system essentially technical in character The basic requirement for nondiscrimination is then passed on to the ground terminals for application to all areas which they may serve The allocation of satellite channels and the charges for them are also covered Other provisions define the limitations and prerogatives which attach to the Corporation's management function under the Committee and state the interests of all parties in the inventions and technical data derived from the operating function No liability is chargeable by a signatory against the Corporation or any other signatory because of satellite or ground terminal failure Disputes under the agreement are to be handled by arbitration

The United States had on more than one occasion formally invited

the Soviet Union to participate in the preliminary discussions which this country had carried out in advance of reaching the interim and special agreements The first invitation was ignored Then in the late Spring of 1964 the Soviet side requested a meeting (Its chief representative had no known relation to communications matters) The Soviet group expressed its view that the US was bent upon commercial exploitation of communications satellites in a discriminatory fashion However no country prepared to share in the costs and/or tasks of establishing a global communications satellite system has been denied participation It is widely assumed that the Soviet Union has little practical requirement because of its unitary land mass for communications satellites Nevertheless it would be premature to read the Soviet Union out of this activity

The achievement of the interim and special agreements remains a remarkable one for which the working level leadership in the Department of State as well as the officers of the Corporation deserve considerable credit The obstacles both political and technical were formidable Success may be attributed in the most general sense to political decisions here and abroad that cooperation was to be achieved In a narrower sense the readiness of US interests to proceed on their own, technically and financially was undoubtedly a contributing factor

* * *

Still another type of mechanism well worth consideration in connection with international cooperation is the direct commercial tie without benefit of such a governmental framework as applies in the case of communications satellites EUROSPACE an association of European industries interested in space serves to introduce the subject of commercial international ties [26]

EUROSPACE is somewhat analagous to our trade associations in general and to the Aerospace Industries Association in particular It enlists some sixty or seventy companies on the continent and in the United Kingdom in activities calculated to raise the sights of European governments in their space planning Thus EUROSPACE has laid out broad space programs which it has commended to the notice

of ESRO and ELDO, as well as of individual countries in Europe (Such planning, of course has no official character) EUROSPACE has retained an American company on at least one occasion for the purpose of providing a critique of its proposals the critique con cluding that the time scale of the European effort should be accel erated and its budgets increased

EUROSPACE has sought status of some kind for direct dealing with official space agencies in Europe as well as in the United States However these agencies are reluctant to extend official recognition to commercial organizations although informal contacts are encouraged

Of special interest is EUROSPACE s invitation to American com panies to become associate members of the organization Over half a dozen have taken up this invitation and at this writing the American companies were planning to host a EUROSPACE conference in the United States during 1965 This innovation—perhaps experiment is a better word—reflects a growing interest in the aerospace industry in international corporate ties of one kind or another This interest in turn grows out of experience in the closely related munitions in dustries in which companies everywhere have found that their efforts to share in foreign markets are likely to be more successful if they first associate themselves with companies native to those markets Rather than confine themselves to domestic markets only, many firms have broadened their philosophy to the point that they are ready to accept foreign participation in their own markets as a necessary quid pro quo for entree abroad or for necessary technical assistance The rationale is two fold first the total velocity and amount of business is likely to be greater with more for all if international markets are opened up second security in the market place rests ultimately upon technical progress and energy

This line of thinking by organized industry as represented both in EUROSPACE and the US Aerospace Industries Association is material to the thinking and planning of government agencies con cerned with international cooperation for several reasons First, com mercial interrelationships are as constructive and effective as any other in developing that matrix of international ties and understand

ing which we seek through cooperation Second it devolves upon the government agencies to facilitate these commercial relationships because their success depends in the final analysis upon the political and regulatory climate which the government agencies create in the area of export controls Clearly the maximum freedom for such exports consistent with hard security requirements is desirable—not only to proliferate interrelationships but also to contribute to an acceptable balance of payments Finally commercial interests can be enlisted directly in cooperative relationships For example it is clear that foreign governments desire the involvement of their industries in advanced technology just as we seek the advancement of our own industry through space technology in order to realize one of the important benefits of space research and development programs This interest in industry s participation in advanced technology gives foreign governments a motivation to enter into cooperative programs with each other and with the United States One can visualize a pattern of arrangements under which foreign agencies might join in the development of future NASA projects on a cooperative basis, each agency meeting its obligations through contracts to its own industry NASA stands to gain in that a foreign agency underwrites a portion of the NASA program The foreign agency gains in that it partakes in space development without having to underwrite total programs Indeed the ISIS program *(see page 44)* is an outstanding example of such an arrangement the Canadian Government contracting to its own industry for an agreed portion of the established NASA ionospheric satellite program The pattern has also been applied in reverse NASA contracting with American industry for the engineering of the second British satellite *Ariel II*

Such patterns could well develop through industry initiative as well the cooperative element being supplied when foreign government finances all or part of the cost of contracts performed by its industry

With sufficient enlightenment in both government and industry commercial ties could well become a most important element in cooperative international programs with tangible benefits all around

not least of which would be the reduction of those trade and technology barriers which have contributed so much to major political difficulty in the world and even in the Western World

* * *

The International Astronautical Federation, which began meeting in 1951 annually brings together national rocket societies and private space groups from many countries The Federation embraces the engineers scientists industrialists and laymen who were among the first to take space flight seriously and who as individuals have probably contributed most to it. Operating at some remove from government sponsorship or control IAF members meet in the congenial and professional atmosphere of extensive and detailed symposia, focusing primarily but not exclusively upon the engineering aspects of space technology and exploration In their professional capacities many of its members are closely associated with the direction or implementation of national space programs and so bring to the organization both knowledge and competence in their discussion

However the IAF rests primarily upon a structure of essentially private societies in contrast to COSPAR for example which brings together public or quasi public institutions Governmental agencies are therefore more likely to be closely concerned in the activities of COSPAR and its adhering bodies than in those of the IAF, although supporting both in many ways One reflection of the somewhat different status of the two organizations is the formal designation of COSPAR as an interested observer by the UN Committee on the Peaceful Uses of Outer Space—along with UNESCO the ITU and the WMO

Apart from the exchange of technical information through symposia the IAF has encouraged discussion of the legal and social aspects of space activity in parallel symposia One of its leading figures the late Theodore Von Karman, was instrumental in establishing an Academy of Astronautics as an adjunct of the IAF electing to it distinguished space scientists and engineers from many countries The Academy has established one or more awards to encourage

distinction in space research and exploration More recently, the IAF has initiated special efforts to bring Soviet and American astronauts together in public professional exchanges (unsuccessfully) and to stimulate discussion of such future cooperative pos ibilities as an international lunar laboratory In the latter case, IAF s role must be similar to that of the Pugwash meetings suggesting and stimulating but lacking official basis for initiating projects or programs (though this distinction may sometimes be confused by lack of precision in press reports or by the chance that an IAF spokesman may in an unrelated capacity hold an official position in his government)

A number of observers have remarked the inherently complementary character of the IAF and COSPAR in that the IAF focuses principally upon space engineering while COSPAR concerns itself almost exclusively with space science As the space age matures, the organizations which make up the IAF may well become further in stitutionalized making possible some consideration of a planned relationship between the two bodies Even at the present time some thought might profitably be given to the scheduling of alternating or complementary symposia to the avoidance of overlapping in content and so forth Both organizations have much to contribute to interna tional cooperation in space within their natural scopes of activity

* * *

From time to time suggestions have been made to the effect that a cooperative space program should be based upon the North Atlantic Treaty Organization (NATO) the Organization for Economic Co operation and Development (OECD) or one or another existing body Such suggestions are sometimes made with little awareness of the existing modes and extent of space cooperation A brief comment may therefore be pertinent in this discussion of mechanisms for space cooperation

Of primary concern is the fact that the European community has itself selected the machinery through which it wishes to conduct civil space research and exploration namely ESRO and ELDO In the face of this fact advocacy of an alternate base for cooperation however

will tend to simplify the subject matter and eliminate at least some of the peripheral considerations encountered when scientific functions are attempted by political bodies Nevertheless international political organizations can make substantial contributions through endorsement and financial support of international scientific efforts

The development and operation of space vehicles and rocket systems of all types with the elaborate ground support required is essentially a technical function of engineering character with strong scientific backing It is now carried out exclusively by national and multinational operating agencies Economic, security, and other considerations leave little question but that governmental agencies primarily of a national character or under close national control must for some time retain direction over the development, operation and use of space vehicles. Direct bilateral and multilateral agreements between such agencies for cooperative projects have clearly been successful and will no doubt be extended in the future However the early state of the art requires continuing close operational control by the responsible agencies The provision of equipments for direct use by international organizations lacking comparable background is virtually certain at this time to entail degradation of performance and results as well as duplication of facilities, costs and personnel

The use of space technology for practical applications such as communications meteorology and navigation, will undoubtedly be particularly complex internationally, and may differ in each case Communications applications involve commercial interests more directly than other applications and require direct international arrangements of one kind or another So far they have found their organizational" basis at the level of the responsible operating communications authorities in each country concerned, as seems very sensible although this has been buttressed, at government insistence by *government to-government agreements Generally speaking* on both national and international fronts a useful distinction can be made between the experimental phase and the operational phase of space applications developments. With a good deal of necessary interchange between the two agencies primarily of space development

character are likely to carry the experimental work forward while agencies specializing in the application itself (communications, navigation, weather analysis and forecasting) are best suited to take on the operational responsibilities. Thus, on the international level, one will not look to the World Meteorological Organization to design, develop or construct weather satellites or operate such systems or their ground support, but will hope to see WMO recommend standards for world-wide weather observations, provide sponsorship for a global system to be provided and launched by contributing countries, and organize the coordination and dissemination of data.

As international efforts to rationalize the use of space in the interests of all continue, it will be necessary to strike a balance between the national requirements for flexibility and such international restrictions or controls as may be required in the general interest. It must be recognized that the activities of *all* international forums dealing with space matters, whether in basic science, regulation, or other fields, inevitably carry with them political implications. Differences are only those of degree, but this fact has a two-fold significance. First, it should warn us that there is no totally a-political international forum in the space field (because there is inevitably political content whenever discussions between east and west are held). At the same time, the differences in degree are real and provide opportunities to make greater progress on some subjects in certain forums rather than in others. It is important for progress in international cooperation that mechanisms and functions not be confused.

NOTES

[1] Alexander King, "Science and Technology," *Daedalus* (Winter 1961), p. 433.

[2] S. W. Greenwood, "Space and the Western World," *Aeronautics* (May 1960), p. 29.

[3] Principal officers of the ELDO Preparatory Commission were: Ambassador Corrobio di Corrobio (Italy), Secretary General; Mr. William H. Stephens (UK), Technical Director General; P. M. L. Girardin

5

REPRISE

Any analysis of the international elements of our space experience to date tells us that we must at the outset recognize and accept a basic duality in the national motivation We seek new levels of joint enterprise with other nations particularly the Soviet Union yet simultaneously we compete for preeminence and the preservation of the national security There are in short elements of both coopera tion and competition in the picture It is of critical importance that neither factor be argued or pursued to the exclusion of the other Far from being incompatible they must both be advanced in a mature mix of prudence and progress short and long term interest But given our long and necessary preoccupation with national security the greater danger now is that we may slight cooperation—we may fail to take the difficult steps which alone can bring cooperation to substantive fulfillment We must therefore be particularly alert to opportunities for joining our efforts with those of other countries and we will need to be courageous as well as generous in accommo dating our own highly prized projects to these opportunities

We have seen also that science as a medium for cooperation among peoples is indeed international but in the sense of professional in tercour e and understanding There is virtually no evidence of an international quality in science or scientists which can over ride or negate political loyalties or alignments Nor have scientists a special capacity for the resolution of political problems In fact we have seen that science must yield when political reality constrains the organization or content of scientific programs—even those dear to the community Nevertheless the drama and interest inherent in today s

meteorological satellite systems and in the conduct of scientific satellite projects Extensive foreign technical and financial participation in the overseas operations of NASA's tracking and data acquisition network has been a constructive factor in the program Underlying all these activities has been an effective on the job training and university fellowship program for foreign technicians and scientists, again operating on the basis of mutual contribution

The benefits of this international collaboration have been tangible They have been evident in the specific scientific and technical results of joint projects (many of them unique) and in the access afforded to foreign regions to meet scientific or operating requirements Benefits have been forthcoming also in economic terms reducing the cost of certain US space programs stimulating foreign commercial interest in US hardware technology and services and contributing modestly to a favorable gold flow balance Some evidence suggests solid political benefits in that the mounting testimony in international forums to broad participation in our cooperative programs has moderated uninformed criticism of the US space effort itself and has inspired the Soviet Union to upgrade its own performance in these forums The total tangible gain augmented by intangible benefits which we have not tried to assess but do not doubt has established a solid and permanent foundation for more ambitious collaboration in the future (This may be contrasted with less sound projects for attracting international notice which after an initial eclat often have faded from view leaving cynicism rather than faith frustration rather than rapport)

Cooperation with the Soviet Union in space matters has on the other hand been more restricted In the root IGY period and thereafter the simplest scientific exchanges despite the undoubted personal interest of Soviet scientists were bogged in military security and the greater immediate attractions of a competition in which the USSR had a comfortable lead More recently however the US space program has surpassed the Soviet in breadth depth beneficial applications cooperative relationships and even weight lifting capacity These factors evidence of the dynamic force and will behind the

American space effort may combine with other strategic and political factors to dispose the Soviet Union to a greater degree of bilateral cooperation In any case there has been a small beginning toward such cooperation in the Dryden Blagonravov agreements, the most important and promi ing of which provides for the establishment of weather data exchanges and the coordinated launching of weather satellites by the two countries

This modest mellowing has been noted also mainly on the level of appearances, in the other principal channels of contact with the Soviet Union in space matters, COSPAR (the International Com mittee on Space Re earch) and the United Nations Committee on the Peaceful Uses of Outer Space Still other channels exi t and can contribute much to professional exchanges and the broad under standing which is required if we are ultimately to progress to sub stantial program involvement on a cooperative basis But it is important to recognize that not all channels are suitable for the same purpo es The United Nations clearly has a special value and a unique contribution to make in establishing an authoritative govern mental framework for the use and regulation of space The UN can serve also to air the interests and needs of the non pacefaring na tions who are nowhere else represented Efforts to utilize any of these forums to achieve space objectives beyond their authority com petence or command of resources is frustrating wa teful of time and more disruptive to progress in the proper channels than may be realized

> too too often men and nations expect the laws of nature the state of technology and the abilities of people and of institutions to conform to their aspirations instead of making their aspirations conform to the obdurate world of science and technology [2]

We have seen also—in the examples of President Kennedy s United Nations proposal of September 1963 and Sir Bernard Lovell s cor respondence of the previous summer—that the course of the American and Soviet space programs, the difficult and delicate ta k of formulat ing national and international space policy, and the meaning of

specific proposals and reports on these matters all have been seriously and needlessly confused from time to time National as well as human interest could be better served

The hard facts of space cooperation and competition the character *of science and the contribution that scientists can make to interna*tional accord the limitations of cooperative programs and their potential these are not to be confused with negativism There is always the risk that enthusiasts unencumbered by specific knowledge will confuse realism with negativism The enthusiasts tend to ' slip more *easily into the role of prophet and agent of a perfectly peaceful* world[3] But those with responsibility for translating ideas into reality for making programs *work* must give due regard to means channels and objectives This is necessary not necessarily negative and does not constitute fighting the problem (Wohlstetter has observed *that the weapons claque tends to regard the consideration of counter*measures not as necessary but as hostile[4])

Realism is the indispensable ingredient making for success in international cooperation A hard won and limited succe s will be more productive of future successes than will a flamboyant beginning with little solid content

Having said this it only remains to be emphasized that there is every reason to proceed imaginatively aggressively, and even con*fidently to widen and deepen the cooperation which has already been* won in the space field The possibilities for success have been demonstrated and a solid foundation established The vested interests are comparatively few and the major one the early Soviet lead may already have been liquidated in fact though this possibility will require some time to come to general appreciation There is clearly a compelling public interest and high visibility" in space activity The fact that it is linked through common techniques and tools to military matters may make cooperation *all the more important for* there may indeed be some carry over to arms control and inspection The implications of collaboration in space by virtue of its foundation in advanced technology of the broadest character reach far into the economic commercial academic and political life of nations as

[2] J R Pierce Satellite Science and Technology *Science* (July 19 1963) p 244
[3] Albert Wohlstetter Scientists Seers and Strategy *Foreign Affairs* (April 1963) p 474
[4] Wohlstetter *op cit* p 474
[5] Pierce *op cit*

INDEX